President's Perspective
ICASE and the 1990s - Building from Strength
by Bob Lepischak
ICASE President
Canada

During the period 1973-1990, ICASE has extended its sphere of influence to some 80 member associations worldwide. ICASE has met the challenge of its original agenda, that of extending and improving education in science for all children and youth throughout the world by assisting member associations. ICASE has served its members by:

• Developing a communication network through the ICASE Newsletter, a quarterly publication which serves to provide an update on regional and national projects.

• Providing to its members scholarly publications such as Resource Notes, Yearbooks, Commemorative Issues, Proceedings from science education meetings worldwide, and topic specific Annotated Bibliographies.

• Liaising and cooperating on projects with other international organisations including UNESCO, ICSU-CTS and the Commonwealth Secretariat.

• Facilitating, endorsing, or assisting with major world meetings such as the conference on Science Technology and Future Human Needs (Bangalore 1985), the ICASE World Conference (Canberra 1988), and the upcoming World Environment Energy and Economic Conference (Winnipeg 1990).

The challenges of the 1990s are many. ICASE has traditionally addressed the needs of science and technology education. The new world agenda currently being addressed by many nations, is a sustainable development strategy. This approach encourages technological and economic growth but with a stewardship of the environment. Education has a key role in marketing this new approach. Currently under study by the ICASE Executive Committee, is the development of an association platform statement on science education. This platform statement may well serve to make ICASE a partner with nations facing the "new world agenda".

Currently in Canada four representatives from industry, government, post-secondary education and the media act as consultants to ICASE. The aim of the Association is to extend a similar liaison network to other ICASE regions. Emphasis has, as with the September 1990 ICASE Symposium on Industry-Education Liaison (Brussels, September 1990), been on building bridges of cooperation, by educators, with the business community and industrialists. Cadres of regional advisors would serve to extend the networking process.

Mr Claude Gadbois, Past President of the Quebec Science Teachers Association (APSQ), has been appointed as an ICASE Special Project Officer - French/Spanish Liaison. ICASE will endeavour to extend member services to French and Spanish speaking associations.

ICASE will, during the 1990s, continue building on the strength of its publication capability. A Space Science Commemorative Issue is currently in preparation in the United States under the leadership of Dr Linda Crow. The Canadian Association for Science Education is collecting ideas for a "teacher user friendly" booklet of science demonstrations and motivational activities using simple demonstrations and motivational activities using inexpensive materials. The ICASE Newsletter has now been upgraded to a journal - Science Education International.

Individuals who have contributed in an outstanding manner to the promotion of international science education have been recognised by receiving an ICASE Award. Pursuant to the Fifth General Assembly Meeting, ICASE has extended its award scheme to include:

• ICASE Distinguished Service Award
• ICASE Regional Service Award
• ICASE Association Award

Member associations are encouraged to nominate potential recipients to the ICASE Executive Committee.

ICASE has on many occasions been a partner in planning, together with other organisations or associations, science and technology education meetings of interest to the international community. A vision which I have shared with a number of my colleagues from the ICASE community is that of ICASE initiating, planning and conducting a World Congress on Science Education. The experiences of nearly two decades as "best supporting actor" has matured the Association to the point where it is, I believe, ready to take on a challenge of some magnitude. Drawing on the strength of its committee and its member associations, ICASE could provide a world class science education meeting for its members.

The strength of ICASE is its member associations and the committee members who unselfishly give of their time and talents. Building on the existing strengths, ICASE will continue to make large contributions to international science education during the 1990s.

Photo: Bob Lepischak was elected as ICASE President at the Fifth ICASE General Assembly held in Ottawa, Canada in October 1989, following his four year term as Vice President.
New ICASE Award Scheme

The Fifth ICASE General Assembly has approved a new scheme of awards for individuals who make outstanding contributions to international science education. There are three types of awards:

1. The ICASE Distinguished Service Award

This award is made to individuals who have a career history of distinguished service to international science education through their involvement in the international activities of local, regional and global science education organisations.

There will be no more than one such award each year. Any individual member of an ICASE Member Association may nominate a candidate for the award. The nominator must provide to the Executive Secretary by 1 May 1990, a letter of nomination and support, a recent curriculum vitae for the candidate, and four additional letters of support from individual members of ICASE Member Associations, three of which must be from outside the candidate's region.

2. The ICASE Regional Service Award

This award honours individuals who have made a significant contribution to international science education through their involvement in international activities at the local and regional levels. Candidates should have a high regional profile resulting from their involvement with and impact upon several science teacher associations within the region.

There will be no more than one such award per ICASE region each year. Any individual member of an ICASE Member Association may nominate a candidate from their region for the award. The nominator must provide to the ICASE Regional Representative by 1 May 1990, a letter of nomination and support, a recent curriculum vitae for the candidate, and two additional letters of support from individual members of ICASE Member Associations, which must be from two different Member Associations in the candidate's region.

3. The ICASE Association Award

This award recognises individuals who, within their science teacher association, has made a significant contribution to the international activity of their association.

There will be no more than one such award per Member Association each year. An ICASE Member Association may name an individual member of their association to receive an ICASE Association Award, by notifying the Executive Secretary by 1 May 1990.

Regional Meetings in Africa

by Isaiah O Ikeobi
African Representative, ICASE


The Nigeria Federal Ministry of Education is also hosting an Africa Regional Meeting on Science Education Program for Africa (SEPA) at the Ministry of Education Headquarters in Lagos, Nigeria 2-3 May 1990.

Mr Ikeobi (photo above), ICASE African Representative and President of the Science Teachers Association of Nigeria together with Prof O C Nwana, the President of the Forum for African Science Educators (FASE), will be taking the opportunity to brief these regional meetings on ICASE activities worldwide.

Prof John Penick, ICASE Special Projects Officer, is shown here proposing the new ICASE Award Scheme at the 5th ICASE General Assembly held in Ottawa, Canada in October 1989. The Assembly welcomed the new scheme as an important strategy in encouraging and promoting international initiatives in science education within ICASE member associations and regions.

Shown behind is Prof J David Lockard, USA, and his wife Mary. Dr Lockard was the founding ICASE President.
Progress Report on the
ASETT-ICASE International Conference August 1990

by Althea Maund
ICASE Representative
Caribbean-South American Region

In January, the second circular for this International Conference was distributed, calling for abstracts. The Conference is being organised by the Association for Science Education of Trinidad and Tobago (ASETT) with the assistance of ICASE.

The Conference theme is Education in Science and Technology for Development: Perspectives for the 21st Century and focuses on topics such as the impact of developments in science and technology on life now and in the 21st century; curricular trends in science and technology education in the Caribbean and Latin American region and worldwide - primary through tertiary; social and cultural issues in science and technology education; science for all; educational technology and the teaching of science and technology.

5000 attend ASE Meeting
by Drs Jan Hendriks
European Representative
ICASE
The Netherlands

The ASE Annual Meeting held in January 1990 in Lancaster, UK attracted more than 5000 participants, including many from overseas. The extensive program included several sessions concerning international science education.

One of these sessions was a workshop entitled "Stepping into Science around the World with ICASE". In this workshop Sue Dale Tunnicliffe, the ICASE Project Officer for the primary project "Stepping into Science", introduced her plans for this new and exciting international project to approximately 40 delegates representing several countries.

One of the features of the program was a Symposium for delegates of European science teacher associations, involving participants from the UK, Ireland, Belgium, The Netherlands and Greece. The agenda for the symposium included the establishment of European links, reports from European associations, a report on ICASE activities in Europe and beyond, a proposal for the writing of a European SATIS unit, and the establishment of an international page in journals produced by European science teacher associations.

A third circular, outlining details of the program, will be available at the end of March. The venue will be Port-of-Spain, Trinidad and Tobago.

For further information, write to Conference 90, ASETT, Faculty of Education, University of the West Indies, St Augustine, Trinidad, West Indies.

Photo: Althea Maund, an Education Officer in the Curriculum Unit of the Ministry of Education in Trinidad, is a key member of the Organising Committee for the Conference.

Greece. The agenda for the symposium included the establishment of European links, reports from European associations, a report on ICASE activities in Europe and beyond, a proposal for the writing of a European SATIS unit, and the establishment of an international page in journals produced by European science teacher associations.

ICASE Symposium
Industry-Education Liaison
Brussels 5-7 September 1990

Member Associations in Europe, USA, Canada and Australia have been invited to nominate teachers to participate in this symposium. Nominations must be sent no later than 1st April 1990 to:

Jan Hendriks
Konijnenpad 3
7921 BM Zuidwolde (DR)
Nederland

This exciting program is open to 10 international delegates, representing ICASE Member Associations. The seminar and workshop program will be held at the NASA Lyndon B Johnson Space Center, Houston, Texas, USA from 9 July to 14 July.

Based on the last three years' programs involving Canadian science educators, sessions will include illustrated lectures; VIP tours of NASA facilities including Jet Propulsion Labs, Space Shuttle Orbiter Training Facility, Physiological Training Center, Vacuum Chambers, and the Weightless Training Facility; a model rocketry workshop; and social events.

Participants will receive print and visual resources ideal for classroom use. Use of cameras and videotape equipment has been cleared for participants. Full duplication facilities for 35mm slides and NASA video resources are available at the Teacher Resource Center for the cost of blank film and videotape only.

Participants will be responsible for airfare, hotel accommodation (available at very reasonable rates through the organiser), meals and registration fee (Cdn$135). The organisers suggest that science teacher associations, school districts, and local industries be approached to help provide funding support for participants.

The deadline for applications is 30 April 1990. Application forms are available from:

Bob Lepischak
Neepawa Area Collegiate
PO Box 340
Neepawa, Manitoba
Canada ROJ 1HO
Tel 204-476-3305
Fax 204-476-3606
Ervan Uzhyshyn
Science Consultant
Manitoba Education
409-1181 Portage Avenue
Winnipeg, Manitoba
Canada R3G OT3
Tel 204-945-7973
Stepping into Science - a new primary science project

Sue Dale Tunnicliffe has been appointed Project Officer for a new ICASE initiative in primary science known as Stepping into Science. For some time now, Sue has been developing a very successful approach to the teaching of primary science and technology in the UK and it is as a result of this work that Sue proposed to the ICASE Executive the Stepping into Science Project.

The Project aims to establish an international information network for sharing ideas on the teaching of primary/elementary science, and to establish a badge award scheme for primary children throughout the world, motivating them to participate in science activities. A Project Coordinating Committee is being established by a Steering Committee consisting of Lucille Gregorio (ICASE President Elect), Brenton Honeyman (ICASE Journal Editor) and Sue Dale Tunnicliffe (ICASE Project Officer).

One plan is to produce a Stepping into Science Newsletter, containing ideas for class activities, ideas for children to try at home, ideas for families to work together, comments by network users on common problems and issues, and lists of useful resources and contacts.

Sue has presented sessions on the Stepping into Science Scheme at conferences in several regions of the world and, judging from the interest shown so far, the potential of the project appears to be enormous. For further information, contact Sue Dale Tunnicliffe, Stepping into Science Project, 18 Octavia, Bracknell, Berkshire RG12 4YZ, UK.

Changes to the ICASE Constitution concerning Membership

The Fifth ICASE General Assembly passed a number of amendments to the ICASE Constitution during its meeting at Ottawa, Canada in October 1989. As a result, the following categories of ICASE membership are now available. 1990 membership dues are shown.

Full Members
Full members may be national associations for the promotion of science education, national associations for the promotion of education through separate science disciplines, or science education sections of national scientific associations or national educational associations. Membership dues range from US$30 for associations with a membership of less than 100, to US$1200 for associations with a membership of more than 10000.

Associate Members
Associate members may be sub-national groups concerned with the promotion of science education, multi-national associations concerned with the promotion of science education in particular geographical regions, or other international federations and associations. Associate membership dues range from US$30 for groups of less than 100, to US$792 for associations of more than 10000.

Institutional Members
Institutional members may be colleges of education, faculties of education or faculties of education in universities, science centres or science education centres, science museums, or other institutes with an interest in science education. Institutional membership dues are US$50 for small institutions and US$100 for large institutions.

Foundation Members
Foundations interested in supporting science education may become an ICASE member. Foundation membership dues are US$500 for small foundations and US$1000 for large foundations.

Company Members
Company members may be publishers of science books, scientific suppliers, companies producing educational materials of a scientific nature, or other companies with an interest in science education. Company membership dues are US$200 for small companies, US$500 for medium companies, and US$1000 for large companies.

Membership Enquiries
Please direct membership enquiries to Dr Jack Holbrook, ICASE Executive Secretary, Department of Curriculum Studies, University of Hong Kong, Hong Kong.

Plans well underway for 7th ICASE-Asian Symposium

Meetings were held in Hong Kong from 6 to 12 February 1990 between the ICASE Executive Secretary, and representatives of the Hong Kong Association for Science and Mathematics Education (HKASME), Shanghai Science and Technology Society (SSTS), and East China Normal University. The purpose of these meetings was to plan for the 7th ICASE-Asian Symposium to be held at East China Normal University, Shanghai from 29 March to 3 April 1991. The conference theme is Making science education in schools more relevant. The program will include presentations by internationally renowned science educators; poster displays; papers, workshops and discussions. Sessions will focus on:

- The development of more appropriate curricula - integrated science vs separate sciences, STS approaches
- Innovations in teaching - the place of project work, science communication, skills, low cost equipment, fieldwork; technology in education
- Technology in education - effective use of visual aids, industrial visits, the place of the computer
- Research in science education - children's learning in science, assessment techniques
Historical Implications of the Development of Public Education in the USSR under conditions of Reorganisation

by Prof Viktor A Kumanyov

An edited version of an address given at the International Conference on Science Education Ottawa, Canada, October 1989

For some years now, public education reforms have been carried out in the USSR. The initial outcomes vary; there has been appreciable progress in some areas while, in other areas, progress has been slow and there is an urgent need to remedy a number of problems. The process of democratisation in schools is not likely to be smooth and painless; no doubt it will experience obstacles and setbacks.

We readily agree that knowledge, including scientific knowledge, will continue to expand and exceed society's rate of development. In the foreseeable future, we can be confident that educational requirements and expectations will be far higher than they are today. In 10 to 15 years time, providing the democratisation process gains momentum, our society may have educational institutions which meet those requirements. The reform initiatives are generating optimism as they provide an opportunity for scientific, technological and social progress.

The 21st century will no doubt see improved teaching methods (by a new contingent of teachers!), superior technical equipment and more effective text materials - all of which will help students to develop the ability to think creatively and continually widen their scientific and general understanding.

During the initial stages of the reform, it has been difficult to bring about some aspects of the platform due essentially to the few changes which have taken place in school management, which has remained bureaucratic. Progress has been further hindered by a clear disregard for innovation and a lack of liaison between those interested in improving education - the school, pedagogical science, the family, and the public.

Since the 1920s the Soviet school (together with other social institutions) has suffered periods of retreat from democratic principles. The violation of democratic forms of control over the development of education by the public has resulted in the growth of bureaucratic procedures; the establishment of formalism, voluntarism and red-tape in solving various pedagogical and organisational issues; and the appearance of dogmatism and overemphasis in educational content. The Education Ministry of the Union was established in the early sixties, but when Brezhnev - a narrow-minded and dogmatic man - came to power, it was generally thought that changes in education (or the economy) were not possible. This stagnation actively promoted the growth of the bureaucracy in education and effectively cut off the education system from any international experience. In summary, as happened during the Stalin era, it seemed that any effort to develop pedagogics as a science was suppressed. There were, of course, talented educators who contributed significant developments, but those who rejected the Stalinist scholasticism and dull schematics, found it difficult to overcome the formidable isolationism of the school from the real world. Hence perestroika (the reorganisation) even now is struggling along this uneven road of the past.

If we in the USSR seriously intend to establish a different school, we are going to need a different teacher.

From this background, there arose a commitment to stop the landslide that was occurring in schooling and to put education on a path of genuine renewal. Ushinsky said "In education, everything should be based on the personality of the educator, for educational power emanates only from the living source of human personality. No rules and programs, no artificial organism of an institution, no matter how intricate, can replace the personality in education." In this age of rapid progress in science and technology and in the era of computers, the teacher is the key factor in the educational process and in any school reform. When we examine the personalities of teachers, it is as if we are looking into a social mirror, and the mirror, as a Russian proverb says, cannot be blamed for what it reflects! If we in the USSR seriously intend to establish a different school, we are going to need a different teacher.

How can a country afford to save on its teachers - the very ones who prepare the country's future?

There are five million teachers in the Soviet Union and I would suggest that at least 50% of this enormous contingent are teachers by "accident"! No amount of reform or reorganisation will be effective unless we radically change the teaching corps. Perestroika in the USSR has raised acute questions about the teacher. No doubt we need educators who know the subject thoroughly, who are in command of modern methodology, and who are well grounded in the psychology of training - but this is not enough.

Also required are an understanding of culture, a thirst for knowledge, a constant striving to be creative, and an unlimited love for students. Although over 200,000 teachers complete their training annually, the USSR experiences a constant shortage of teachers. In addition the quality of training leaves a lot to be desired. The average salary of a teacher in the USSR is 197.5 roubles - less than the national average salary! How can a country afford to save on its teachers - the very ones who prepare the country's future?
Under Brezhnev, the prestige of teaching and the social status of teachers became quite low. Accordingly many who entered pedagogical higher education institutions used the opportunity to gain a higher education without any intention of becoming teachers. Fortunately, measures are being taken today to prevent this from happening.

The Soviet Union requires a teacher who focuses on children and their inner natures and who is attuned to their individual abilities.

Since the current period of education reform began in 1984, the press has made many suggestions about the type of teacher needed for perestroika and the country's future - the Soviet Union requires a teacher who focuses on children and their inner natures and who is attuned to their individual abilities. There is a need for a new type of thinking professional, who is ready to master the changing content of education and new teaching technologies, who is ready to master a new way of pedagogical and universal thinking. Research in the USSR indicates that there are only five to six percent of such teachers. Although 72% of teachers recognize that there is a need for fundamental changes in schools, half of these have no idea of what needs to be done or how to go about it. Statistics on the feelings of teachers toward their task are important to note - 2% are merely "marking time"; 4% approach their task gladly and willingly; 14% have mixed or changing feelings; 19% regard teaching as a difficult duty; and 61% approach teaching with constant alarm and concern! Many teachers, even though they denounce the directive-bureaucratic style of management, themselves adhere to this approach in their communication with students, placing them under considerable stress. For many teachers, therefore, their most critical task is to achieve an inner perestroika.

The current reform was slow to gain momentum. For some time, there was merely a mention of specific shortcomings - the low level of general knowledge of teachers and students, the lack of quantitative indicators of performance, the poor state of physical education, and others. It was not until after the 1987 and 1988 CPSU Plenums, and the All Union Teachers Congress held last fall, that a change in public consciousness concerning school and higher education establishments became apparent. Since then, there has been an escalation of pedagogical thought, a pluralism of opinions, a lack of fear of dissidence, a focus on historical and present-day experience, including the global context, and a preparedness to consider bold, well-substantiated proposals. Accordingly, many fresh initiatives have arisen from within the teaching profession.

In 1988, the USSR Ministry of Education was abolished and replaced by Ministries of Public Education in the Union Republics. These ministries are responsible for preschool education, school education, professional secondary education, and higher education. The USSR State Committee for Public Education, a newly formed all-union centre for the administration of education, has taken a firm course towards democratising schooling and its administration. However some members of the former bureaucracy remained in control with the result that the comprehensive secondary school reverted again to an eleven-form school - as it had done under Kruschev! The system of classic schools and Luceums is being re-established. These institutions conduct special, indepth programs in areas including languages, literature, logic, mathematics, physics, and history, providing greater opportunities for students to enter establishments of higher learning.

Motivation to learn can only occur in a system of education where there is a love for children. The teacher should not view them as "someone else's" children or youngsters! A teacher should be a model of humaneness, culture and decency and a person to whom a student is able to relate (Koumanov, 1986). Socrates saw each of his students as a friend to whom he did not simply hand on truth, but with whom he sought the truth. Leo Tolstoy, who held that children were more sound morally and more talented than adults, believed that children are inexhaustible wells of intellectual forces, capable of solving the most complex issues and problems and of making breakthroughs into the unknown. These premises point the way to a genuine humanisation of education.

Liberalisation of schooling, as a critical initial step, is untenable unless procedures are put into place for the legal and psychological protection of the student. In terms of perestroika in the USSR, this means placing a categorical ban on the use of any forms of student punishment which lay outside state-approved school regulations, and which infringe upon the dignity of the student thereby causing humiliation. Some schools in Moscow now have psychological and pedagogical commissions, to whom students may apply in the event of a conflict.

Even during this period of perestroika and glasnost (publicity), the time has not yet come for students and
teachers to engage in equal intellectual discussions. Nevertheless, teachers should maintain open dialogue with their students, respond willingly to new ideas by students, and avoid putting up their own ideas as absolute. Children will believe in themselves only if they believe in their teacher.

The development of teaching techniques in the course of educational reform is a complex and many-faceted task requiring the coordinated input of scholars, teachers, sociologists, psychologists and others - a fact which has been acknowledged by the All Union Teachers Congress. The Congress supported moves to develop urgent solutions to the problems of education and endorsed the move by schools and higher education institutions to humanise the education process.

At the commencement of perestroika, the USSR Academy of Sciences was ill-equipped to take up the challenge of providing support for school and higher education reform. Its orientation toward a partial, rather than a radical modernisation of education, its considerable isolation from schools and their needs, its lack of independence due to its position within the framework of the former USSR Ministry of Education, and its poor knowledge of the world experience, meant that it required a substantial reorganisation. To date, the Academy's perestroika has only achieved cosmetic changes, and its isolation from schools and their needs persists (Pravda, 18 April 1989).

The textbook has been used as a "divine service book" with the teacher like a clergyman performing a liturgy.

Textbooks and teaching manuals have, as a rule, been written in dull, inexpressive language with poor graphic support. There has been a desperate need for experienced teachers and scholars who are familiar with the needs of students, to work together in the production of textbooks. Unfortunately, the textbook, usually the one text produced by the millions, has been used as a "divine service book" with the teacher like a clergyman performing a liturgy. Upon my return from a visit to Canada 10 years ago, I shared with colleagues in the Academy of Sciences and the USSR Ministry of Education, the concept of producing a series of short modular texts (such as I had seen in Canada) in order to supplement the curriculum and provide opportunities for students to select a wider variety of content options. Although many appeared to nod their approval at the time, the idea was typically not taken up. However, the bureaucratic wall is beginning to collapse. Today, textbooks in many areas are being updated. Perestroika is correcting a number of serious distortions which have been perpetuated through older textbooks.

There is a serious shortage of technical facilities for schools and higher education institutions. Computers have the potential to generate more time for teachers to be creative, as well as accelerating communication and the exchange of information, but the State allocates insufficient resources in the field of education to provide computer facilities on a wide scale. Even if they were to be provided, there would be insufficient computing specialists to train educators in their use. Television programs on computer education are broadcast, a magazine Computer Science and Education is published, and computing seminars are periodically held at the State University of Moscow and other universities, but these are timid, first steps in a psychological perestroika in accepting computers as modern working devices.

Perestroika and glasnost have provided a perfect opportunity to confront the problems.

The main objective of the reform is to move away from a static approach to education based on hopelessly out-dated reference knowledge, to a "scientific" approach that models the processes of science and reflects the dynamics of scientific and technological progress. As Lenin emphasised as early as 1920, in order to manage, one needs to be competent, to know totally and thoroughly all conditions of production, to know the machinery involved in production, and to have a certain "scientific education" (Lenin, 1920). It is only since the period of perestroika that the term "scientific education" has received serious attention.

Perestroika and glasnost have provided a perfect opportunity to confront the problems and revise the methods of teaching, the selection of content, and even the selection of teachers themselves. The positions of instructors at higher education institutions are now being declared vacant after five years. Salary systems are being reviewed according to certification. No doubt the USSR Union of Teachers will continue to promote change and to see that words are being put into practice.

It is critical that schools ensure that children's capabilities are recognised as early as possible, and that children are helped to develop their true potential. My father, a well known Soviet pedagogue, used to say "Children should be loved as they are with all their shortcomings, but with a faith that they have a great future, and that kindness will bring out the very best in them. While loving children as they are, it is essential to perfect their nature, and to inspire them to be optimistic about the possibility of their own perfection" (Koumanev 1986).

References
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Lenin V Collected Works Vol 40, 1920, p215
About the Author
Professor Viktor A Kumanyov is the Corresponding Member of the USSR Academy of Sciences, and the Vice Chairman of the University Department of History.

Acknowledgement
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Integrated Science Teaching in Thailand

by Manee Chandavimol

The rapid advance of science and technology during this decade has made a significant impact on our society, and it is in the field of science education where the greatest effect of this impact can be seen.

The teaching of science in Thai schools has received increased attention since this subject forms the very foundation of technology. Our students need to be educated in a way that will enable them to contribute to and, indeed, to thrive in an ever-changing world. The development of science curricula, therefore, must be a continuous process, allowing the teaching and learning of science to become more dynamic and more relevant to the needs of society. To facilitate this process it is imperative to implement a program of frequent assessments and revision to evaluate the effectiveness of the curricula and to make appropriate modifications.

Rationale

In Thailand, the national policy has now placed emphasis on science and technology for the development of economic and social welfare. It also recognises the need to educate people so that they may be able to more wisely make use of the growing capabilities science and technology now offer. A close look at our science curricula revealed that some areas were inadequate. The tremendous growth in the range and application of technology during the years since our IPST integrated science curriculum was first implemented in 1978, had rendered the science curriculum inadequate in fulfilling the plan of the national policy.

From the follow-up program and research study on the implementation of the IPST integrated science curriculum, there was evidence suggesting that some topics were too difficult for the age level being taught, and some needed modification. Furthermore, there was a need to improve the flexibility of the integrated science curriculum to better accommodate the local situation in order to fulfil the general aims of the national education plan. Also, there was a need to emphasise the development of inquiry processes of learning, enhance student attitudes and interest towards science, and promote creativity so that students would be well prepared, educated members of society.

The modification of the curriculum

Although some minor changes and improvements to courses had been implemented, it wasn't until 1988 that Ministry of Education approved a major revision of the IPST integrated science curriculum (grade 7-9). The original philosophy of the 1978 IPST integrated science curriculum was found to be still useful. Its features reflected a student-centered approach; an emphasis on inquiry approaches to teaching; the integration of various fields of science (chemistry, physics, biology, environment); the development of science process skills; and the relevance of applications to students.

In accordance with the 1988 IPST integrated science curriculum, the curriculum objectives have placed more emphasis on the understanding of science and technology for the development of society and quality of life and, in particular, a positive attitude towards science. The nature of the course has been modified by integrating the teaching of technology at a level appropriate to students' abilities. The overall emphasis is concerned with the daily life of students and the quality of life in general.

In Grade 7, the focus is on the basic requirements for life such as water, matter, plants, animals and the environment. In Grade 8, studies are extended to include the topic of the human body - body function, mechanism and growth. In Grade 9, topics become increasingly concerned with technology as it relates to both our daily lives and the environment around us - for example, the development and conservation of our natural resources, and energy as it is used in daily life and communication. This course involves 3 periods of study per week.

Teaching approach

In addition to the curriculum content changes, teaching methods have been examined and improved. More emphasis is now being placed on encouraging students to perceive science as interesting and challenging. To achieve this, teachers are providing opportunities for students to take part in discussions and activities, to conduct investigations through experiments and science projects, to perform role plays, etc. These activities may take place both in and out of the classroom, in a school science club or independently at home.

**Objectives**

**IPST Integrated Science Curriculum**

- Develop an understanding of the basic principles and theories of science
- Develop an understanding of the nature, scope and limitations of science
- Develop skills important for scientific investigation and communication
- Develop a scientific attitude
- Develop an understanding of the application of science to everyday life and of the consequences of science on people and their physical and biological environment
- Be able to apply the knowledge and understanding of science and technology for the development of society and the quality of life
- Develop students' respect for, interest in and curiosity about science and technology
Problem solving skills are being developed and practised regularly in order to promote reasoning and creativity. Skills include observation, collecting and organizing data, forming hypotheses, predicting outcomes, recognising advantages and disadvantages, and being able to take all parts of a problem into consideration. It is hoped that such skill development will enhance student self-reliance and contribute to their ability to solve problems in their own lives.

Teaching materials

Teaching-learning materials have undergone many improvements. Textbooks are now written so that content is integrated with activities; they include more experiments and problem solving questions for students to do in and out of the classroom; they contain more examples of technological applications related to daily life in Thai society; and they include more pictures and cartoons which illustrate concepts and heighten student interest and enjoyment.

Teachers' guides have been written concurrently with texts. They clarify objectives for activities and experiments; summarise the concepts and principles of each activity; list equipment and chemicals required; include suggestions for alternative activities; and contain sample answers to student questions.

Supplementary reading materials for teachers provide additional background to help teachers answer questions, provide explanations and choose appropriate activities for their local situation. They also include an enrichment program of reading, activities and projects for students who have a special interest in science.

Trends and current issues

An important trend in science education today is the move towards a balance between scientific knowledge and scientific processes. The science course described here is a core program, designed for all junior secondary students with the aim of inspiring an interest in science, as well as providing them with the scientific knowledge and skills needed to become productive and responsible members of society. In order to accommodate the various needs, interests and abilities of students, additional elective courses will be offered, thereby helping students to prepare themselves to meet the challenges that their future plans will bring.

With the environment as a world-wide issue, the public needs to develop an understanding of the environment, its importance, how it is being threatened, and how it can be protected and conserved. There is a need for the study of the environment to be introduced earlier in a child's education, and to be a more prominent part of the curriculum - at present, it is a mere part of an integrated curriculum. There is a need, therefore, to develop a new course - environmental science - with a "hands on" emphasis through field trips and science projects.

Another trend concerns the use of educational technology in the teaching of science. With the advent of the use of computers in the classroom, the practicality and relevance of computers must be considered. There are problems concerning the appropriateness and quality of software, and the lack of trained personnel. Meanwhile, greater use could be made of existing technology such as slide-tapes, transparencies, videos, etc.

The role of the teacher remains a vital one, although it has changed from being an instructor to being a facilitator. Teachers cannot be replaced by computers or machines - the human relationship in the learning process will always be indispensable.

Concluding remarks

The rapid advancement of science and technology has had a significant impact upon education; as a result, science educators, science curriculum developers and science teachers must strive to be well acquainted with current events and the latest research not only in the field of science education, but also in the area of science and technology. Ongoing staff development is crucial, and requires special attention if we wish to keep our curriculum up to date and relevant.

In order to achieve high standards of education, further support is essential from both the government and the private sector. Cooperation with business and industries can help provide practical course materials and direct experiences for students. International and regional cooperation is also essential if we are to enhance science curriculum development. As science educators, we need to access information and ideas through international and regional workshops, seminars and publications.

About the author

Manee Chandavimol is the Deputy Director of the Institute for the Promotion of Teaching Science and Technology (IPST) in Thailand.
Science, Technology and Mathematics for All
A report on the 6th ICASE Asian Symposium
Brunei Darussalam, 4-10 December 1989

by Dr Jack Holbrook
Executive Secretary, ICASE
University of Hong Kong, Hong Kong

Science, technology and mathematics for all was considered from three perspectives:

- Informal education: the need to assist the general public to better appreciate science; the need to popularise science thereby promoting its image.

- Nonformal education: the promotion of student out of school activities which motivate students and help to redress gender differences.

- Formal education: relevant science, technology and mathematics appropriate for all; the move to contemporary models which encourage skills such as problem solving and decision making.

Science teacher associations are in a position to provide much needed assistance to teachers, although association efforts and expertise may not have always been recognised.

In the area of informal education, associations can contribute by arranging lectures on popular science topics for the public, and by inviting the general public to attend various science competitions, displays and exhibitions which are organised by associations.

Associations can promote nonformal education through organising out of school programs such as science fairs, science weeks, student competitions and student badge award schemes.

Formal education poses the greatest challenge to science teacher associations. Here, efforts are directed to the teacher rather than the student. Associations can help teachers to interpret the curriculum by arranging seminars, and by publishing guidelines, viewpoints and ideas in their newsletters and journals. Many teachers need help in translating the curriculum for a particular class in a particular locality.

Associations can do much to provide resources and support in the form of teaching resources, newsletters and journals, low cost equipment, industry/field visits, and lectures by specialists. In addition, associations have an important role to play in providing curriculum development support in areas such as assessment methods and development of teaching materials. They can provide a source of suggestions and tips for teaching, produce helpful publications, arrange talks, and initiate projects involving collaboration between teachers.

Through networks such as ICASE, science teacher associations can help teachers to widen their horizons by making formal or informal links with teachers in science teacher associations in other countries. Possibilities include the exchange of curriculum materials (visual aids, equipment, printed materials, case studies), a program of exchange visits, and the organisation of regional and international symposia for teachers.

Needs for Education in the 1990s

by Dr Kenneth R Roy
North American Representative, ICASE
NSSA National Director, USA

In a recent Curbstone Clinic Series sponsored by the National Science Supervisors Association's LISE Center, supervisors of science, mathematics and technology education developed a joint list of needs for education in the 1990s. Four groups - two science, one mathematics and one technology education - first met by discipline to brainstorm needs. A second session was used to combine disciplines with representation in each group by supervisors of science, mathematics and technology education. The common element outcomes of each group were then focused on to develop an action plan. Included in the list of six items were:

1. **Interdisciplinary curriculum development:** Supervisors saw the need to begin building bridges to other disciplines. The real world is spectral in vision and experience. Today's school curricula deter learning in this
respect. Interdisciplinary instruction can be a successful approach and needs to be explored. However, ultimate success depends upon securing discipline credibility. A variety of highly successful pilot programs exist such as science/technology education courses.

2. Staff Development: With the advent of a myriad of national reports and recommendations, supervisors need to be effective catalysts and change agents. A major component in effecting these changes is the school district’s commitment to providing staff development programs. These go well beyond simply providing workshops. Teaching faculty must be directly involved in program development, planning, evaluation and more. A program designed to only meet organisational needs is unrealistic and can be totally ineffective. The supervisor needs to be able to help facilitate this process if staff development is to be successful.

3. Scheduling: As supervisors move to meet the needs of students and faculty into the 21st century, new models for scheduling must be adopted. This issue is especially true for science and technology education where hands-on programs are critical at the elementary and secondary levels. Innovative scheduling models, possibly even beyond the regular school day, may be necessary to entertain.

4. Coordination and articulation of the Curriculum K-12: A major concern of supervisors was the lack of knowledge and skill coordination horizontally and vertically in the curriculum. As science curricula move toward “step learning”, it is imperative that we consider models of coordination and articulation. One model is to provide additional release or planning time for faculty committees with K-12 supervisors as facilitators to focus on improved coordination and articulation.

5. Linkage to the real world: The learner must have practical applications to real world situations. If these disciplines are to be motivating and meaningful to students, there must be linkage or relevance to their real world experiences. Science, technology and society (STS) and other approaches foster practical applications in learning for students. As noted in Project 2061, there must be education provided for all students, not just for the select few who will become scientists, technologists or mathematicians. In this way, it is imperative to cross old discipline lines. Mentorship programs for faculty, supervisors and students are one of several components which serve to provide bridges to the real world.

6. Finding resources to support change: A major concern on the part of supervisors was the need for change agents to have resources. The need for and types of resources will vary from district to district and school to school. However, some common resources may be secured through business and education alliances, Federal government programs, state programs, professional association resources and, most importantly, professional networking.

The LISE Center is a leadership development and resource center of the National Science Supervisors Association. Its services include providing Curbside Clinic programs on issues relevant to science supervisors and teacher advocates.

For additional information, please contact Dr Kenneth R Roy, NSSA LISE Center, Copernicus Hall (Suite 227-228), Central Connecticut State University, New Britain, CT 06050, USA.

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Primary Science Workshop Report
Sierra Leone, Africa, 7-9 August 1989

An edited version of a report by Samuel E Johnson
President, Sierra Leone Association of Science Teachers

The Sierra Leone Association of Science Teachers (SLAST) organised and conducted a workshop for primary science teachers from the 7th to 9th August 1989. 30 participants attended, representing 20 primary schools in the Freetown area. The workshop aimed to:

- Provide an opportunity for primary teachers to share and acquire experiences in teaching science using the officially prescribed text *Primary Science for Sierra Leone*.
- Familiarise teachers with the principles and objectives of the primary science course.
- Explore ways for teaching topics effectively regardless of school location.
- Identify areas of possible misinterpretation in texts in order to correct them.

Participants formed into three groups or resource teams. Resource team A focused on the teaching of process skills to pupils with a particular emphasis on observation, recording of information, and classification. Practical exercises with living organisms enabled participants to focus on skill development, and to gain elementary knowledge of the structure and life of animals and plants likely to be encountered in the children’s environment.

Resource team B discussed problems relating to the teaching of agriculture at the primary level. Ideas discussed included selecting a garden site and producing livestock. Participants also classified crop plants, and studied crop diseases. Recommendations to the Ministry of Education, Cultural Affairs and Sports included making available land for schools or groups of schools to use in the teaching of agriculture, providing fencing and security personnel for this land, and funding the establishment of small scale animal husbandry programs.

Resource team C focused on the physics and chemistry aspects of the science program. Participants carried out a number of simple experiments including the absorption of water by different materials, the making of mixtures, the effect of heating on substances, and the reflection of light using mirrors.

A more detailed report of this very successful workshop can be obtained by writing to the Editor.
To Encourage, Don't Praise

by John E Penick

Abstract
Verbal praise, often seen as a necessity in the classroom, may, in fact, be more negative than positive. Rather than encouraging a student to learn, praise may have exactly the opposite effect. Encouraging learning can be more effectively accomplished by listening to student responses, giving attention to students, and providing recognition for efforts rather than mere praise.

Motivating students to learn has always been a major problem faced by teachers. Some have faced the problem squarely and honestly, seeking to motivate through interest and good teaching. Some have resorted to gimmicks and ruse. Still others have denied the problem by asserting that the teacher's role is to provide teaching skills and content and the learner's is to provide motivation.

Likewise, educators have spoken widely and eloquently on the subject. Many educational strategies using praise or other outside rewards have been devised and implemented while reams have been written about the individual's strong need for praise. An equally vocal segment condemns praise, reinforcement, and behaviour modification as inhumane, manipulative, and not in accordance with the goals or best interests of our society. Teachers, meanwhile, are caught in the middle, wanting to encourage and motivate, not wanting to harm children, but not being absolutely sure about what is best.

Praise
Many studies (O'Leary and O'Leary, 1977; Lipe and Jung, 1971) have demonstrated well that praise can be reinforcing when it is used to reward the performance of a specific behaviour or skill. It has often been pointed out that people tend to learn along whatever lines they find rewarding (Torrance and Myers, 1970). Unfortunately, teachers may not always use praise in a deliberate reinforcement attempt. In fact, praise may be a spontaneous reaction to a student behaviour (Brophy, 1979).

Several classroom studies of praise indicate it occurs far less frequently than criticism and punishment and is often used inappropriately. Other studies found teachers giving more praise to high ability students than low ability students (Brophy and Good, 1974). Good students tend to get praise for good answers, less able students get praise for non-less related aspects such as dress or appearance. Praise for behaviour often goes to those students who are high achieving, quiet, conforming, and hardworking - clearly those least in need of reinforcement of such behaviour. And, praise has been shown to be motivating only when directly focusing on significant performance. In addition, for praise to be effective it must be given privately, for public praise of one may be viewed as rejection by another and even embarassing for the one praised.

Even if used correctly and specifically, praise may still pose a problem for teachers. The use of praise may lead to results which are not desired. It has often been noted that praise implies differential status. The giver of praise becomes the authority who is judging the person receiving praise. Further, many find praise embarassing and it may lead to dependent behaviour on the part of the individual receiving praise. Praise reduces rather than increases motivation when the person has previously been performing a behaviour for its intrinsic value (Deci, 1975). Many students, unless they are very immature or teacher dependent, feel manipulated or punished by praise. Actually, the teacher may be the one being manipulated. Several studies indicate that much teacher praise is elicited and reinforced by students themselves (Brophy, 1979).

Teachers, through praise, may also be promoting rather covert sexism in our schools. Dweck et al (1978) noted that teachers praise boys for successful performance and girls for neatness, following instructions, speaking clearly, and other matters of form rather than substance. When making negative evaluations, teachers criticise girls for unacceptable performance and boys for form. As a result, boys attribute their success to their own ability and their failures to the external attitudes of the teacher or their own efforts. Boys are encouraged by this pertinent praise and ignore criticisms. Girls, on the other hand, are not encouraged by praise since much of it is for form rather than substance. Girls are very discouraged by criticism since they attribute their failures to their own lack of abilities and their successes to the external factors. Girls see this as personal inadequacy. They try their best but still fail. Giving girls (or anyone, for that matter) praise when they have attained no object may lead to undue reliance on others for direction and evaluation.

If students do see and understand the use of praise they may be humiliated if it is directed at them (my teacher must think I'm really dumb if she praises me for that!). Or, such students may question a teacher's competence if they
see the teacher praising work which is mediocre.

A brief summary should make most teachers cautious in their use of praise for any reason:
- Praise is not synonymous with encouragement.
- Praise does not generally correlate with increased student achievement.
- Praise does not always or even usually function as a reinforcer.
- It is questionable whether praise can be successfully used as a reinforcer except in one-to-one interactions.
- Praise may not have inherent value.
- Many find praise embarrassing or punitive.
- Teacher praise is often under the control of student behaviours.
- Teachers tend to praise "teacher's pets".
- Pressure from without rarely promotes desirable behaviour.

Encouraging children

To encourage children without risk of negative overtones, teachers can help students learn to set goals and to evaluate their own performance. In doing this, students supply self-reinforcement without relying on the teacher. Then, they can attribute positive outcomes to their own efforts rather than to the teacher or other external causes.

Teachers who encourage put value on the child as he is, not just as they wish him to be. To do this teachers must have faith in the child and his own ability. Having faith is shown by focusing on strengths and assets, helping in skill development, and using the interests of the child to organise instruction. Rather than correcting the child, teachers must encourage self-evaluation by asking questions which require reflection. Encouraging also means giving the child recognition for effort, success, and individuality. Teachers can give recognition verbally by asking questions, responding to answers or other comments, and by taking time for meaningful interaction. Nonverbals such as glances, smiles, or winks also let a student know they are noticed.

By guaranteeing the student certain rights and privileges, providing opportunities for success, and accepting, teachers do much to encourage a child's learning and self-concept. It is also useful to be pleased with a good attempt, letting them know they can do it. At the same time, the students must feel that, in your class, it's alright to try; failure is no crime. They will feel this and be encouraged if you show confidence in their ability to become competent and capable.

References

Deci E 1975 Intrinsic Motivation. New York: Plenum

Prof John E Penick, Science Education Center, University of Iowa, USA, has researched creativity and the effects of teacher behaviour on students.

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Coal nations to cut carbon dioxide

An environmental report

Leading coal producing nations are planning to introduce new technology to reduce carbon dioxide output from the burning of coal by up to 50 per cent as the debate about the greenhouse effect warms up. The technological developments were the key topic of discussion at a meeting of the eight nation International Committee for Coal Research in Sydney, Australia recently.

The committee's chairman and president of the National Coal Association of the US, Mr Richard Lawson, said that while much of the technology was still in the laboratory stage, the nations were confident that it could be applied soon to plants using coal to produce energy.

Mr Lawson predicted the new technology would be operating in several countries by 1991, when the committee will hold its next meeting to present its findings to the world's scientists. Research indicated the new technology - which involves the use of more efficient equipment such as coal burning ovens which capture negative emissions - could improve the efficiency of plants by 25 to 45 per cent, he said.

Mr Lawson denied the coal producers' research was being spurred on by growing debate about global warming and the effect on the atmosphere of the carbon dioxide output from the burning of coal. He said he believed the improvements in the energy conversion process would develop faster than the on-going debate on the greenhouse effect.

At present, the International Committee for Coal Research was committed to putting the technology into the hands of developing nations such as China, India and Brazil. Mr Lawson said although the new technology would not be cheap, its cost would be offset by greater efficiency.

From Habitat Australia, December 1989

14
Building Questioning Power

Ronald J Bonnstetter

Science Education Societies from all over the world are placing new demands on classroom teachers. Teachers worldwide are being asked to develop students who possess critical thinking skills, problem solving ability, and powers of analysis. Not only are these goals quite different from our tradition of fact dissemination, but they call for very different teaching strategies.

The role of questioning by the classroom teacher can play an important role in addressing this international objective. The following activity has been used effectively to help both preservice and in-service teachers to recognize their own questioning behaviors and learn to ask many different kinds of questions.

Participants are first surveyed to determine their knowledge of Bloom's Taxonomy and how this can relate to different levels of questions. Then to simplify the process, knowledge and comprehension level questions are grouped and called closed-ended questions. Application, analysis, synthesis, and evaluation questions are referred to as open-ended or extended-answer questions. Participants are given a simple numeric code for different teacher verbal actions. For example, number 1 stands for closed-ended questions and 2 for open-ended questions. Once participants have shown an understanding of these differences and can code various questions, the following activity is used.

Participants are placed in groups of three and given the following assignments and information. In each small group, one participant is responsible for coding the interaction, while another role-plays the questioner (teacher) and the third the respondent (student). Only three minutes are allowed for this first exercise after which time roles are switched and another coding period occurs until all three participants have performed each task. The assignments vary with the role. The questioner is to find out all he/she can about, for example, favourite hobbies, by asking as many open-ended questions as possible. The responder is to answer these questions without getting carried away giving information that was not specifically requested. The responder is also encouraged to listen closely and answer all closed-ended or short answer questions and yes/no questions accurately. For example, "Can you tell me what your favourite hobby is?" should be answered with a simple "Yes".

The coding for this first activity is kept at a very simple level by grouping all responses into only four categories - short answer question, extended answer question, student response, and, if noticeable, wait time. The resulting three minute coding is almost always dominated by short answer questions. Debriefing usually exposes the fact that coming up with open-ended questions on the spot is very difficult.

The next day, after discussing several papers designed to build their understanding and rationale for questioning, a second questioning activity is conducted. To reinforce the idea that open-ended questions do not arise spontaneously, each participant is told in advance to come prepared with at least five open-ended questions. The topic is up to them but should be an area of science for which they feel extremely comfortable and that other members of their group would have very little knowledge.

Additional rules include allowing the questioner to build a small content base by making two or three sentence statements that lead into their questioning. Again, the questioner is to make every effort to ask extended answer questions and allow time for responses - wait time. The coders for this second round are asked to start looking for an additional code - probing. This code is used when the teacher asks the student to clarify or expand their comment.

The third day questioning activity focuses on using the student response. For every question and answer given, the teacher is requested to ask for clarification or in some way use the information obtained before going on to the next prepared extended answer question.

This simple activity has been very well received by both preservice and in-service teachers. A teacher recently shared how the activity had affected his teaching. He was known for ending class with "Do you have any questions?" and found that by simply asking "What questions do you have?" he now receives many more questions. Being aware of one's behavior is the first step to improving.

About the Author
Ronald J Bonnstetter is Director of Secondary Science Education at the Center for Curriculum and Instruction, University of Nebraska, Lincoln, Nebraska, USA.
Dr Ang Wai Hoong
Singapore

Ang Wai Hoong is a staunch believer that science is for all and she enthusiastically promotes the learning of science through the fun way. She takes the stand that academic learning at school is important and that science club activities give more relevance and added meaning to the learning of science in the classroom.

She has served the Science Teachers Association of Singapore in various capacities, and was Chairman for 6 years. She is still an active member. She was the driving force behind the establishment of the Singapore Science Fortnight which is a major annual event for about 100,000 pupils between the ages of 9 to 19 years old. It has now become a major regional event which attracts to it teachers and students from Brunei, Malaysia, Thailand, Philippines, Hong Kong, Australia and New Zealand.

She initiated the Young Scientist Scheme in 1985. Since then, thousands of pupils in primary schools wear badges as Young Ecologists, Young Chemists, etc. Primary schools in Singapore now have science clubs which hold school zonal as well as national exhibitions undertaken by them.

Having obtained considerable educational experience in Australia, England, United States and Singapore, she has sought to integrate the outstanding features of each system and apply them in the Singapore context. She has made key contributions to the way science is taught at school, first as Assistant Director of Science and then as Deputy Director of Curriculum at the Ministry of Education. She continues to influence the teaching of science in her current position as Director of the Curriculum Development Institute of Singapore where science text books are being published. Currently, she is strongly promoting the greater use of technology in the teaching of science. She has presented papers in this area at conferences in several countries. She also holds positions on the Singapore Science Centre Board, the Governing Board of RECSAM (SEAMO), the Basic Education Advisory Council, the National Computer Board, and is Chairman of the Association for Supervision and Curriculum Development (ASCD) Singapore.

Dr Ang has always been a strong supporter of ICASE and its activities, and organised the very successful ICASE-Asian Symposium held in Singapore in 1981. In recognition of her significant impact upon and contributions to international science education over many years, she has been honoured with the ICASE Award.

Netherlands bold pollution plan
An environmental report

The Netherlands has unveiled details of an ambitious long-term environmental plan which aims to cut all forms of pollution by at least 70 per cent by the year 2010.

The Dutch Environmental Minister, Mr Ed Nijpels, predicted the plan would become a model for other European nations, especially West Germany, which has joined the Netherlands at the forefront of the green camp in the European Community.

Under the scheme, the total cost of environmental clean-up efforts sustained by Government, producers and consumers would nearly double to FL15 billion by 1994. About 80 per cent of costs will be borne by the polluter - industry, farmers or consumers. Industry is expected to pass to consumers 60-70 per cent of its added costs. By 1994, each household is expected to be paying FL130 a month towards saving the environment - 50 per cent above current levels.

The plan includes several hundred measures to cut pollution in soil, air and water by 70-90 per cent over the next 20 years. The measures would reduce acid-causing sulfur emissions, greenhouse gases and conserve energy.

Mr Nijpels said the plan was based on the idea of sustainable development, the notion that economic growth must not jeopardise future generations' ability to provide for their own needs.

He said that, by some indicators, the Netherlands was the most polluted country in Europe because of its high density of population, cars and industry. The Dutch feel acutely vulnerable, because of their geographical location, to air and water pollution from West Germany and Britain. Their country is also the most intensively farmed in Europe.

From Habitat Australia, October 1989

16
Science from everyday materials  
by Sue Dale Tunnicliffe  
Primary Science Section Editor

One of the constant comments received from primary teachers all over the world is that science requires resources which primary schools do not have. While we do need some technical resources, most elementary science topics can be studied using items which are readily available.

One of the features of the ICASE Stepping into Science Project is that children can investigate the same topic but use different resources to assist them in their studies. The resources used vary according to where they live.

You are invited to share your resources with others in the ICASE network. What, for instance, do you use in your school:

• to function as a container for investigating solubility  
• to make electric circuits  
• to function as a pipette  
• to function as masses  
• to measure volume  
• to house small animals

The collection of Stepping into Science activities (challenges) is growing. These challenges have been organised into a number of stages or levels.

What do you think? Is it appropriate to have a series of activities structured according to various levels of difficulty? Many of the tasks collected so far can be investigated at a number of levels of difficulty according to whatever science skills a child may have.

Send your ideas to:

Sue Dale Tunnicliffe  
ICASE Project Officer  
Stepping into Science  
18 Octavia  
Bracknell  
Berkshire RG12 4YZ  
UK

Getting wet!

Here is an activity for your pupils to try. Stepping into Science involves children in the following steps:

• Planning their investigation  
• Choosing equipment to use  
• Carrying out their investigation  
• Recording their observations and measurements  
• Communicating their findings to a wider audience

Challenge  
What happens if you put a drop of water on different kinds of surfaces?

Discussing  
Ask what is a drop? How do you put a drop on a surface? Will you need special equipment? Can you let it drip off a finger? How can you make this fair? What kind of surfaces can be used? What do you predict will happen when drops of water are put on different surfaces? Will the drop stay as a drop? Will the drop soak into the surface? Will the drop run off the surface?

Planning  
Ask how they will carry out this investigation. What will they do first? If they are working in a group, what jobs will each do?

Choosing equipment  
Ask what equipment they will need. They may need a container for water, and various surfaces such as newspaper, flat stone, foil, cotton fabric, wood, bread, sand, leaf, etc. Drops can be placed onto surfaces using a pipette, a straw, or simply a finger.

Doing the activity  
Do pupils change their plan as they do the activity?

Recording  
What observations are they making? How are they recording their observations?

Evaluating  
What did they observe? What does it mean? What have they found out?

Communicating  
How will they share their findings? Children are welcome to send a report to Sue Dale Tunnicliffe, ICASE Project Officer for the Stepping into Science Project.
Ozone depletion - What can you do?
A student activity

Chlorofluorocarbons or CFCs are a family of chemicals. Although not directly hazardous, over recent years there has been increasing scientific concern that when released into the atmosphere they damage the ozone layer. There is now international agreement that CFCs should be controlled because of their potentially damaging effect. Public opinion has been heightened by the recent media attention given to the 'ozone hole' over Antarctica. The major uses of CFCs are in refrigerators and air conditioners, the making of plastic foams and some aerosol products.

ACTIVITIES

• Survey the aerosols at home (e.g. the bathroom, laundry and kitchen).
• Make a list of those products containing chlorofluorocarbons or freons (another name for CFCs). How many did you find?
• Go to the supermarket and try to find alternative products that do not use CFCs.
• Write down any alternative products next to your original list.

• Are there any products you could not find alternatives for? Discuss these items with your classmates.
• Show your parents your list and suggest that they consider buying the CFC-free products. Explain why.

CFCs are used in a multitude of products that are part of our everyday lives. With a little effort and knowledge you can help prevent ozone damage by buying wisely, refusing to use non-essential products and by explaining to others how emissions can be minimised.

DISCUSSION POINTS

• How would labelling of products containing CFCs reduce emissions?
• How is public education and awareness related to labelling?
• What options are there for recycling?

• What alternatives are available for CFC products?
• What are the effects of increased ultra-violet radiation?
• Car and other airconditioners can be a large source of CFCs if not properly maintained. What maintenance can be done to minimise emissions?
Assessing a technology
A student activity

Our society and environment have been dramatically affected by technological change - just think, for example, of the effects of the motor car! At present there are many new technologies like communication satellites, superconductors, wind, and solar power generation competing for public support and acceptance.

But which technologies should be supported? Should some be opposed? Many people think of technologies simply as tools which are neither good or bad in themselves. But it can also be argued that the solar panel and the nuclear reactor cannot be understood merely as different types of hardware. They are products of different human values and purposes and may serve very different social interests. A lot of the publicity given to new technologies is just another form of glossy advertising. But who tests the new technologies for their social and environmental costs and benefits?

Paste a picture "advertising" a new technology in the middle of a large sheet of paper. Divide the paper into four sections as shown below. Write your answers to the following questions in the appropriate sections:

Section A
What values, assumptions, purposes and social interests seem to have led to this technological innovation?

Section B
What might be the social and environmental consequences of this technology becoming widely used?

Section C
Why might people support this technology's widespread use?

Section D
Why might people oppose this technology's widespread use?

Science and Technology in Society - a new project for 7 to 14 year olds
Reprinted from Science Education Newsletter, January 1990 published by The British Council

The success of the Science and Technology in Society (SATIS) materials for 14-16 year olds led to the SATIS 16-19 Project. A new three year project, Early SATIS, has been launched by the ASE with financial support from industry. The Early SATIS Project aims to:

- Introduce 7-14 year old pupils to the SATIS approach
- Broaden the base of science and technology experiences, giving them a social context

The project will address the needs of teachers by helping to develop teachers' own understanding of science, especially the place of science in society.

Further information about the project is available from:

John Stringer
ASE Early SATIS Project
University of Warwick
Science Park
Sir William Lyons Road
Coventry CV4 7EZ
UK

Acknowledgement

The activities on pages 18-19 are based on the teacher's notes and activity sheets in Our Changing Environment: A Choice of Futures, a publication produced by the Commonwealth Department of the Arts, Sport, The Environment, Tourism and Territories, Australia 1988. A number of ideas and activities in this package are adapted from R A Slaughter Future Tools and Techniques, Lancaster, UK: University of Lancaster, 1987; and from J Fien "The Future of the Australian Environment" in Living in the Australian Environment, Canberra CDC, 1988.
Resources

Clean water - a right for all

This resource pack for teachers contains explanatory notes for teachers with background information on the discovery of bacteriology, water-borne diseases, the effect of flood and drought, and water supply and sanitation around the world. There are also suggestions for activities, with photocopyable worksheets, to allow children, aged 8 to 13 years, to discover the properties of water and its place in their lives. The resource pack has been published by Unicef and is available at a cost of £5.95 from Unicef-UK, 55 Lincoln's Inn Fields, London WC2A 3NB, UK.

Evaluation of teaching effectiveness

A selection of principal papers presented at the ICASE Europe Research Seminar on the evaluation of teaching effectiveness held in Caserta, Italy in October 1989, has been published in a special edition of the journal of AIF, the Italian Association for the Teaching of Physics. The papers have been published in both English and Italian. Copies of the journal are available (£5.00 or US$8.00) from Dennis Chisman, Honorary Treasurer, ICASE, Knapp Hill, South Harting, Petersfield GU31 5LR, UK.

1989 ICASE Yearbook
Science education and the quality of life

This 200 page publication includes 6 theme addresses and 50 selected papers which were presented at the ICASE World Conference/CONASTA 37 in Canberra, Australia, July 1988. The yearbook includes papers on developments in science education, social and ethical issues, people and health, computing and educational technology, the environment, industry and technology, energy, chemical science and technology, and science education research. Copies are available (Price £7.00 or US$12.00) from Brenton Honeyman, ICASE Journal Editor, 10 Hawken Street, Monash ACT 2904, Australia.

PASCO scientific
An ICASE Company Member

PASCO scientific has been a designer, manufacturer, and distributor of educational physics apparatus for over 25 years. Their equipment supplies the educational laboratories of most major universities in the United States, as well as universities, colleges and secondary schools in over 35 other countries.

As a distributor, PASCO carries a diverse range of over 400 products covering all the disciplines of physics. Along with the classics of educational physics, such as the air track and the force table, they also carry the latest computer aided experimental systems and simulation software.

As a designer, PASCO's efforts have two main thrusts. The first is to update and upgrade the classic equipment of the physics lab, such as developing an "air track" for studying rotational motion, or designing a more complete optics system that incorporates magnetic mounting. This also includes implementing modern manufacturing techniques to provide equipment of a higher quality at a reduced price. The recently completed h/e Apparatus, for example, can be used to study the photoelectric effect and to measure Planck's constant with much greater accuracy and reliability than was previously possible in student labs.

The second thrust of PASCO's design effort is to develop equipment and software that enables educators to use the computer more effectively in labs and demonstrations. PASCO's Smart Pulley, for example, is an inexpensive instrument that provides a versatile link between the computer and almost any moving object (dynamics cart, pendulum, mass on spring, etc).

PASCO prides itself in being a "full service" supplier. Each piece of equipment comes with a complete manual. Where applicable, the manual will include one or more worksheet style experiments that can be photocopied for use directly by the students - some systems come with 10 or more experiments in the manual.

Beyond this, PASCO maintains a technical support staff that knows physics equipment and physics. With direct access to the equipment designers and to active educators, they can provide helpful technical assistance in selecting and in using their equipment. As the manufacturer of most of what they sell, PASCO can ensure rapid after sales service so your equipment will always be ready for use.

For more information on PASCO's line of educational physics equipment or to receive a free copy of their catalogue, contact your local representative, or:

PASCO scientific
10101 Foothills Blvd
PO Box 619011
Roseville, California 95661
USA
Tel 1-916-786-3800
Fax 1-916-786-8905
TWX 910-383-2040
ICASE is keen to arrange regional or world events for the benefit of member associations. If your association or organisation is interested in hosting an international seminar, workshop or conference, contact the Executive Secretary or your Regional Representative. To gain ICASE endorsement, the meeting must be international in nature, open to member associations, and, while all sectors of the science education community should be encouraged to participate, must be relevant to classroom teachers.

1990

April 5-8
National NSTA Convention
Location: Atlanta, Georgia, USA
Contact: Michael J Padilla, University of Georgia, Science Education, 212 Aderhold Hall, Athens, Georgia 30602, USA

April 8-11
NARST Annual Meeting
Location: Atlanta, Georgia, USA
Contact: Jane Butler Kahle, Chair, NARST Program Committee, 221 WTHR Bldg, Purdue University, West Lafayette, IN 47907, USA
The National Association for Research in Science Teaching invites educators to participate in the program of contributed papers, poster sessions, panels, symposia and round table discussions.

April 22-27
International Symposium on Fieldwork in the Sciences
Location: Field Study Centre, Orvelte, Netherlands
Contact: Drs Henk Lindeman, Secretary of FISFIS, Field Study Centre, Zuiderweg 10, 9441 TZ Orvelte, Netherlands
This symposium has been endorsed by ICASE and aims to acquaint participants with different curricula and developments in fieldwork for geography, physics, biology, chemistry and science subjects. Teachers in primary, secondary and tertiary education, teacher trainers, staff members of field study centres, curriculum developers and others interested in the integration of fieldwork and education are invited to attend. The symposium will be conducted in English and includes active fieldwork sessions based on world trends in fieldwork, plenary sessions on the role and implementation of fieldwork in environmental education, poster presentations, workshop and discussion groups, and fieldwork excursions. A Proceedings of the symposium will be prepared.

April 23-27
International Conference on Physics Education through Experiments
Location: Tianjin, China
Contact: Prof Li Chun, President, Peking University Branch Campus, Beijing, China
This international conference, a joint activity of the International Commission on Physics Education (ICPE) and the Asian Physics Education Network (ASPEN), will focus on the use of demonstration experiments, student home-made experiments and modern teaching aids in the teaching of university and high school physics.

May 6-11
GASAT Conference: Science and Technology - A Future for All
Location: Jonkoping, Sweden
Contact: Ingrid Granstam, European & Third World GASAT Secretariat, Jonkoping University College, PO Box 2264, S-55002 Jonkoping, Sweden
"Science and Technology - A Future for All" is the main theme of this second European Conference. The framework for contributions will be (1) girls and women in science and technology education: from preschool to higher education and in adult education formal and informal experiences; (2) women in the workplace: in science and technology at all levels. Important themes are seen to be progress and promotion; training and retraining; recruitment and retention; coping strategies in a male environment; feminist strategies on technology; evaluation of strategies for change; historical perspectives; future perspectives.

June 6-8
ICASE Europe Research Seminar
Location: University of Dortmund, Dortmund, F R Germany
Contact: Prof Dr Hans-Jurgen Schmidt, Department of Chemistry, University of Dortmund, Otto-Hahn-Strabe, D-4600 Dortmund 50, F R Germany
The theme of this research seminar is "Empirical Research in Science and Mathematics Education". The aim of the seminar is to discuss the methodology of empirical research in this field. Approximately twelve 40 minute papers will be presented (in English) and then discussed. A Proceedings will be printed and available through ICASE.

June 7-9
Second European Conference on Health Education
Location: Warsaw, Poland
Contact: Mrs M A Modolo, Europe Office, Centro Sperimentale per l'Educazione Sanitaria, Universita di Perugia, CP 35 PG 3, Via del Giochino 4, 06100 Perugia, Italy
Organised by the European Region of the International Union for Health Education, this conference will focus on young people as the target group. Innovative educational
approaches will be introduced to improve communication and the quality of health education. During the conference, a competition organised particularly for secondary school pupils, based on their own interests (environment, school life, community) will take place.

June 25 - July 6
Second International Workshop on New Technology Course Materials
Location: MEDC, Paisley, Scotland, UK
Contact: Dr Peter Williams, Director, MEDC. 8/14 Storie Street, Paisley PA1 2BX, Scotland, UK
This cooperative workshop will develop materials for the new technologies. Groups from different institutions and countries will select topics of common interest on which to produce computer aided learning packages, videos, open learning or other appropriate materials. All resulting materials from all groups will belong to all participants.

July 4-6
ASPEN Regional Workshop II on Conceptual Structures and Change in Physics Learning
Location: Quezon City, Philippines
Contact: Dr Vivien Talisayon, ISMED, University of the Philippines, Diliman, Quezon City, Philippines

July 9-13
CONASTA 39 Annual Conference of the Australian Science Teachers Association
Location: Alice Springs, Northern Territory, Australia
Contact: Peter Deacon, Convenor, CONASTA 39, PO Box 705, Alice Springs NT 0871, Australia
The CONASTA 39 theme is “Science Education and Technology for the 90's”. The Conference will provide a forum for science educators to examine important issues confronting us in the new decade. The program includes keynote addresses, practical sessions, excursions and social events. This is an ideal opportunity for visitors to experience the world renowned attractions of central Australia.

July 9-14
NASA Space Science Seminar and Workshop
Location: NASA Lyndon B Johnson Space Center, Houston, Texas, USA
Contact: Evhan Uzhybshyn, Science Consultant, Manitoba Education, 409-1181 Portage Avenue, Winnipeg, Manitoba, Canada R3G OT3
This program is open to selected applicants from Canada and up to 10 international delegates. Application forms must be submitted by 30 April 1990. The program includes special lectures by NASA researchers, and an extensive program of visits to facilities including the site research and testing facility, NASA Jet Propulsion Labs, Space Shuttle Orbiter Training Facility, Physiological Training Center and the Weightless Training Facility. Participants will be responsible for their own airfare, hotel accommodations (at group rate), meals, and a registration fee of Cdn $135.

July 14-17
1990 ASERA Meeting
Location: Freeway Hotel and Curtin University of Technology, Perth, Western Australia
Contact: Dr David Treagust, SMEC, Curtin University of Technology, Bentley, WA 6102, Australia
Science educators interested in science education research are invited to attend the annual meeting of the Australian Science Education Research Association, an ICASE member association. For those attending CONASTA, there will be a direct flight from Alice Springs to Perth on the 14th July. A subsidy is available for those presenting their first ever paper.

August 19-24
Third International Conference on Teaching Statistics
Location: University of Otago, Dunedin, New Zealand
Contact: The Secretary, ICOTS 3 Local Organising Committee, Department of Mathematics & Statistics, University of Otago, PO Box 56, Dunedin, New Zealand
ICOTS 3 aims to improve the quality of statistics instruction on a world-wide basis, fostering international cooperation among teachers of statistics, and promoting the interchange of ideas about teaching materials, methods and content. The program includes plenary, invited and contributed paper sessions, workshops, panel and poster sessions. Teaching from beginning school to college, polytechnic and university level will be included, as well as sessions on teaching statistics in government, business and industry. Opportunities will be provided to see and experiment with the latest computer hardware and software. You are invited to submit a contributed paper, workshop, poster or exhibit.

August 26-31
SCICON 1990
Location: University of Canterbury, Christchurch, New Zealand
Contact: Conference Secretary, SCICON 1990, Department of Continuing Education, University of Canterbury, Christchurch, New Zealand
SCICON 1990 will be the seventh biennial conference of the New Zealand Science Teachers Association. Workshops, laboratory sessions, seminars, discussion groups, access sessions, and keynote addresses will address the theme Science for tomorrow’s world. The program also includes field trips and visits to research institutes, industries and places of scientific interest.

August 27-30
ASETT-ICASE Conference on Science & Technology for Developing Countries
Location: Port of Spain, Trinidad, West Indies
Contact: Conference 90, ASETT, Faculty of Education, University of the West Indies, St Augustine, Trinidad & Tobago, W1
The Association for Science Education of Trinidad and Tobago (ASETT) in collaboration with ICASE will host a conference on “Education in Science and Technology for
Development: Perspectives for the 21st Century." The conference will be open to science and technology educators of all countries, but Caribbean problems will be of particular interest. The conference aims to provide a varied program focusing on (1) scientific and technological developments as they impact upon our lives at present, and are likely to impact upon our lives in the 21st century; (2) social and ethical issues consequential on developments in science and technology; (3) the thrust of modern technology and the implications for science and technology education; (4) educational technology and the teaching of science - developments in resource materials production for the teaching of science and technology; (5) appraising present curriculum trends in science and technology education in the Caribbean and Latin American subregions and worldwide; (6) the schools and universities/industry interface; (7) bridging the gap in science education - primary through tertiary; and (8) action towards the goal of science and technology education for all with appropriate emphasis on the popularisation of science, science clubs and out of school science activities.

August 31 - September 2
CTC-IUPAC Meeting: International Symposium on the Environment and Chemistry Teaching
Location: Moscow State University, Moscow, USSR
Contact: Prof Y Treutinkov, Chemistry Department, Moscow State University, Moscow 117234, USSR

September 5-7
ICASE European Symposium on Industry and Education
Location: Brussels, Belgium
Contact: Drs Jan Hendriks, ICASE Executive, Konijnepad 3, 7921 BM Zuidwolde (Dr), Netherlands
Invitations have been sent to member associations of ICASE and to other bodies in Europe, USA, Canada and Australia to nominate education representatives to attend this seminar. Industry representatives are being invited by Conseil Européen des Fédérations de l'Industrie Chimique (CEFIC). The symposium is being organised to (1) provide opportunities for the exchange of information and experiences in schemes for industry-education liaison, (2) develop models for industry-education liaison, (3) establish a network for information exchange for future developments, and (4) publish a resource book for teachers and administrators on industry-education liaison.

September 10-20
Seminar on STS Education
Location: University of Oxford, Oxford, UK
Contact: The Director, Courses Department, The British Council, 65 Davies Street, London W1Y 2AA, UK
The British Council announces its forthcoming seminar on "Science Technology and Society Education: Developing a Relevant Science Education for the Future." This seminar has vacancies for 40 participants and is intended for experienced science teachers, senior educators with responsibility for science curriculum development, school science inspectors and advisers, and teacher trainers. The seminar will consider a wide range of educational issues which arise when science and technology are taught in the context of their social interactions. The following topics will be considered - rationale for STS, developing new curriculum materials in schools, innovations in teaching STS, research into STS in the classroom, studying the environment, ethical and gender considerations, monitoring changes in new technology, media influence on our students' ideas, and the way forward.

October 18-20
World Environment Energy and Economic Conference
Location: Winnipeg Convention Centre & Holiday Inn, Winnipeg, Canada
Contact: Mr Jack Pyra, Past President STAM, John W Gunn School, Winnipeg, MB R2C 3C9, Canada; or Mr Bob Lepischak, Vice President ICASE, Neepawa Area Collegiate, Neepawa, MB R0J 1H0, Canada
This conference, endorsed by ICASE and the Canadian Association for Science Education, and hosted by the Science Teachers Association of Manitoba, will focus on the theme "Sustainable Development Strategies - The New World Agenda". A program is being prepared to interest educators, youth and the general public. Businesses and industries are being invited to participate. The conference will enable participants to examine and discuss the links that must be fashioned so as to integrate environmental concerns with continued development on the energy, resource and economic fronts. The program will address the role that curriculum, teachers and schools can play in helping students understand the environmental realities which are the cornerstone of sustainable development.

An International Symposium on Sustainable Development will precede the conference on October 15-17. International representatives from education, government and industry will meet to examine the implication of sustainable development upon the curriculum and students of tomorrow.

November 7-11
NABT Annual Meeting
Location: Westin Galleria & Westin Oaks Hotels, Houston, Texas, USA
Contact: National Association of Biology Teachers, 11250 Roger Bacon Drive, Reston, Virginia 22090, USA
The theme of this conference is Planet Earth in Crisis. International delegates are welcome. A feature of this year's program will be contributions by international participants and an international reception.

December 12-14
ASPEN Meeting on Demonstration Experiments and Computer-Aided Learning in Physics
Location: Pune, India
Contact: Prof Arun Nigavekar, Physics Department, Poona University, Pune, India
December 27 - January 1
International Conference on Teaching of Physics
Location: Karachi, Pakistan
Contact: Mrs Aziz F Hasnain, Head, Department of Physics, APWA Government College for Women, F 'B' Area, Karachi, Pakistan
The theme of this international event is The changing face of physics education in developing countries. The conference aims to discuss techniques for conceptual teaching in physics, to create awareness among physics teachers about modern teaching methods including the use of computers and audiovisual aids, and to establish a research program in physics education.

1991

March 27-30
NSTA National Convention
Location: Houston, Texas, USA
Contact: Linda Crow, Asst Professor, Baylor College of Medicine, One Baylor Plaza, Room 633E, Houston, Texas 77030, USA

March 29 - April 3
7th ICASE-Asian Symposium
Location: East China Normal University, Shanghai, China
Contact: Dr Jack Holbrook, Executive Secretary, ICASE, Department of Curriculum Studies, University of Hong Kong, Hong Kong
The ICASE Executive Committee have accepted a proposal from the East China Normal University in conjunction with the Shanghai Association for Science and Technology and the Shanghai Board of Education to host an ICASE Conference in March-April 1991. The symposium will be conducted in English/Mandarin and will address the theme Making science education in schools more relevant. The program will focus on (1) the development of appropriate curricula, the issue of integrated science vs separate sciences, the introduction of STS in science courses; (2) innovations in teaching, the role of project work, the teaching of science communication skills, low cost equipment, fieldwork; (3) technology in education, the effective use of visual aids, visits to industry, the place of the computer; and (4) research in science education, children's learning in science, assessment techniques. The program will consist of presentations by internationally renowned science educators; papers, workshop and discussion sessions; poster displays; and an exhibition.

July
GASAT 6 International Conference
Location: University of Melbourne, Victoria, Australia
Contact: Ms Gaell Hildebrand, School of Education, University of Melbourne, Parkville, Victoria 3052, Australia
In order to be placed on the mailing list for calls for papers, etc, write to Gaell Hildebrand at the address above.

August 4-9
ChemEd 91 Conference
Location: Oshkosh, Wisconsin, USA
Contact: Bruce G Smith, Co-Director, Appleton High School-West, Appleton, Wisconsin 54914, USA or Paul Kelter, University of Wisconsin, Oshkosh, Wisconsin 54901, USA
ChemEd 91 is a major chemical education conference of interest to university, college, secondary and elementary educators from North America and beyond. Throughout the weeklong conference, activities are planned for all members of the family including excursions, field trips, sports activities and social events - a feature of ChemEd conferences.

August 25-30
11th International Conference on Chemical Education
Location: University of York, UK
Contact: Dr John F Gibson, ICCE 11, Royal Society of Chemistry, Burlington House, London W1V OBN, UK

August 26-30
Fourth Asian Chemical Congress
Location: Beijing, China
Contact: Prof Dehe Zhang, Secretary General of 4ACC, Chinese Chemical Society, PO Box 2709, Beijing 100080, China
The 4th Asian Chemical Congress will be held under the sponsorship of the Federation of Asian Chemical Societies. The Congress will focus on the important role of chemistry in raising the health conditions and living standards for all people. The program of plenary lectures, invited papers and contributed papers will be conducted in English and will concern various topics including organic chemistry of natural products, analytical chemistry and instrumentation, environmental chemistry, agrochemistry, coordination chemistry and its applications in medicine and agriculture, polymer science, photochemistry, computers in chemistry, catalysis, and chemical education.

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ICSU CTS
ICASE News

Feature Article
Chemistry in Dance, Drawing, Drama and Daily Life
Prof. Zafra M. Lerman

Science Education Around the World
The Effects of STS Instruction on Student Learning
Robert E. Yager

Research for Teaching and Learning
Building and Assessing a Teaching Rationale
Ronald J. Bonnstetter & John E. Penick

Science Teacher Education

Primary Science

Science Technology Society

Resources

Calendar

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Individuals £9 per annum, Libraries £18 per annum

or to one of these subscription centres:
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Jack Holbrook, ICASE Executive Secretary
Department of Curriculum Studies, University of Hong Kong, Hong Kong
Individuals HK$120 per annum, Libraries HK$240 per annum
Editorial
ICASE - enhancing its image through publications
by Brenton Honeyman
Journal Editor

Since its inception in 1973, ICASE has been active in the area of publications, providing to its members scholarly publications such as Resource Notes, Yearbooks, Commemorative Issues, Proceedings from science education meetings worldwide, and topic specific Annotated Bibliographies.

ICASE is currently undertaking a number of new initiatives to extend its services to member associations, institutions, centres, foundations and companies.

This journal, which has taken the place of the ICASE Newsletter, is an important component of ICASE's strategy to not only strengthen communications with and services to member associations, but also provide useful resources directly to individual science educators who are interested in what is going on in science education around the world. Hence this new journal, Science Education International, is available through a low cost subscription scheme to individuals and libraries.

I encourage member associations to take every opportunity to promote this journal to individuals and libraries in their countries. As the number of subscribers grows, the Editorial Team can increase the size of the journal to include more feature articles, more news of science education around the world, more practical ideas for educators in primary, secondary and tertiary classrooms. Your support in making the journal known will help ICASE to produce a bigger and better quarterly publication for us all.

ICASE is enhancing its reputation of producing quality publications - not only in content, but also in presentation. If you haven't yet seen some of the recent publications produced in recent months, order a copy of the just released

<table>
<thead>
<tr>
<th>This section provides news for the information of member associations, institutions, centres, foundations and companies. The Executive Committee encourages members to reproduce this section in journals and newsletters to communicate this information to as many as possible.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commemorative Issue entitled APOLO 11: A Teacher Resource Book, or the 1989 ICASE Yearbook: Science Education and the Quality of Life, or the report on the ICASE Europe Research Seminar: Evaluation of Teaching Effectiveness. See page 22 for details of how to order these and other affordable ICASE publications.</td>
</tr>
<tr>
<td>ICASE is currently developing an information pack ICASE - the people and the organisation, which includes a profile on the people within the ICASE organisation, and the activities and projects in which ICASE has been, and is currently involved. This information pack will also contain position statements on science education; relationships with member associations, other international organisations and business and industry; and priority areas for future action. This information pack, once the position statements have been adopted at the next meeting of the Executive Committee in January 1991, will be useful in ICASE's endeavour to widen its network of member associations, institutions, centres, foundations and companies; and to enter into collaborative projects with other organisations, business and industry.</td>
</tr>
<tr>
<td>Another new ICASE initiative is the Who's Who in Science Education Around the World 1991 Edition. This valuable reference book will contain profiles on prominent science educators and their work. The information will help you to contact colleagues in both developing and developed countries who may be working on projects of interest to you, who may be potential speakers at your next meeting or convention, or who may be invited to work on collaborative projects. Copies will be sent to all ICASE member associations, institutions, centres, foundations and companies. Copies will also be available to individuals and other organisations at an affordable price. See insert for further details.</td>
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Photo: Brenton Honeyman, Editor of "Science Education International", in his home office where the quarterly ICASE Journal is produced. It is here that the various sections of the journal are wordprocessed, edited and compiled into page proofs using a Macintosh SE computer. The Editor prints page masters to 300 dpi resolution using a laser printer, and sends these air express to Dr Jack Holbrook, ICASE Executive Secretary, who supervises the printing and distribution of the journal to ICASE member associations, and a growing number of individual and library subscribers worldwide.
Stepping into Science in the Middle East

by Sue Dale Tunnicliffe
ICASE Project Officer

The ICASE Primary Project Stepping into Science has been gaining momentum in several countries. One of the latest regions to become involved in the project is the Middle East.

Yunus Solar, a science teacher at the British School - Muscat, has implemented this approach to primary science education with 4 to 8 year olds. He has developed colour coded certificates for use at different levels. Other teachers in the region may order these certificates (please indicate how many of each colour and include postage).

Yunus Solar can be contacted at the British School-Muscat, PO Box 4907, Ruwi, Sultanate of Oman.

He will share how he has implemented the Stepping into Science program in his school at the ASE Annual Meeting in Birmingham, UK in January 1991.

This ISY (International Space Year) conference was sponsored by NASA and CNES (Centre National d'Etudes Spatiales, France) and hosted by CNES on behalf of the Space Agency Forum of the ISY (SAFISY). This meeting was a direct follow-up of the Frascati SAFISY meeting held in April 1989, and focused on the education and applications aspects of ISY. 175 participants from 41 countries, including developing countries in the regions of Africa, Latin America and Asia, participated in the Deauville meeting. Some representatives had been nominated by ICASE and ICSU-CTS. The conference was organised around two main themes.

Theme A focused on remote sensing training applications, and was chaired by Dr Isaac Rivah of CNES, France. Theme B focused on education and space, and was chaired by Dr Frank Owens of NASA, USA.

Theme A was further subdivided into three working groups: (1) environment resources, monitoring and management (2) geology and natural hazards (3) urban and environmental planning. Theme B was also subdivided into three working groups: (1) earth observation in education (2) space science in education (3) space communications in education. Each of the working groups produced recommendations for specific projects and activities.

The Space Science in Education group, chaired by Bill Aldridge, Executive Secretary of NSTA, USA, formulated a number of suggestions, including:

• Production of an annotated bibliography of resource materials for space science education in schools and colleges
• Teacher training courses, including 1991 summer institute programs in the USA for teachers from overseas countries
• Space Olympiad for students
• Development of teaching modules for space science
• Worldwide distribution of a special 1991 edition of Quantum devoted to space science. Quantum is a students' journal produced in the USSR, and is now published in an English version by NSTA.

Dr David Moore, General Secretary of ASE, presented these suggestions on behalf of ICASE and ICSU-CTS to the Deauville conference. A proposal was developed to produce an international set of resource materials on space science for teachers of science, complementary to the ICSU-CTS curriculum project on global change. This proposal includes:

• Production of an annotated bibliography of existing documents and publications relating to space science in schools, using the networks of ICASE, ICSU-CTS, INISTE (UNESCO), etc.
• Compilation of existing teaching and learning resources into a publication suitable for use by students. This would include visual materials, computer software, etc., and be compiled using ICASE and other networks.
• Development of exemplar modules on space science useful for enriching science lessons.

It was proposed that this project be undertaken during the period 1990-91 so that materials are published and distributed in late 1991.

The proposal for an International Space Olympiad in 1992 involves student teams drawn from existing annual Olympiads in chemistry, mathematics and physics, augmented by earth and life science team members. The final competition would take place on a global video hookup.
This Finite Earth
by Chris G Trump
Honorary Conference Chair

World Environment Energy and Economic Conference
Winnipeg, Canada, 17-20 October 1990

It was the Apollo astronauts returning from the Moon who remarked that our planet looked like a blue marble in the vastness of space - a spacecraft in its own right that alone held the promise for the sustenance of human life. Just as they were dependent on the narrow confines of their capsule to stay alive, so the astronauts’ earth has its limits in ensuring life for the billions that inhabit its surface. We discharge noxious gases into the atmosphere; pour pollution into the waters. But in the end there will be no escaping the penalties of these practices. Acid rain leads to lakes devoid of life and hillsides denuded of forests - to say nothing of the mighty works of man - the Acropolis, cathedrals and other structures that crumble in the onslaught. Rivers and coastlines are no longer fit for fishing or for swimming as offal and algae blooms give warning of worse to come.

Yet hope springs eternal. When the Cuyahoga River of Ohio caught fire and Lake Erie threatened to become a dead sea, a joint US and Canadian effort reversed the toll. In Toronto blue boxes cart away bottles, plastic and cans for re-cycling; in Europe huge incinerators preserve landfills and generate heat as a by-product. In the Soviet Union citizen action is serving notice that the world’s deepest body of water, Lake Baikal, must not go the route of Lake Erie. Conscience drives us to a new consciousness because, in truth, we are all looking...not only at what we are doing to each other, but to those who will come after us.

All of these signs are positive, yet they need continual reinforcement. Too often profit for the present subsumes preservation of the future. Out of sight, out of mind is a mindset that is difficult to overcome. The blob in the St Clair River, the dead zone in the Atlantic offshore from New York, the sump that is Halifax Harbour - all bear mute testimony to the human condition.

Ways must be found to engage another human imperative - that of profit - in halting this abuse. What needs to be driven home is that to preserve and conserve pays better than to waste and pollute. Self-interest sustained, if you will, can do more to improve our mutual lot than the common good ignored.

This was the purpose of the Brundtland Commission’s examination of Our Common Future. It sought sustainable development as something to meet the needs of the present “without compromising the ability of future generations to meet their own needs.”

It is a tall order, and much of the report seems to deliver itself of a catalog of problems, followed by a telephone book of solutions: “Solving the impending urban crisis will require the promotion of self-help housing and urban services by and for the poor, and a more positive approach to the role of the informal sector, supported by sufficient funds for water supply, sanitation and other services.”

What is urgently needed now is to make a few of these calls and begin to show by way of example what must be done. Water supplies just don’t happen - they are made. And they must be paid for. So it is with sanitation - and all the other services. A wish list is not a program.

That is why the World Environment Energy and Economic Conference is such an important event. Here in Winnipeg - a city grappling with its own water needs - will gather planners, government officials, businessmen and concerned citizens. The objective will be to learn from programs that have worked and to chart new ones that will widen the circle of sustained development. How can good water pay for itself? In what ways can the proper diversion of pollution pay dividends?

This conference seeks to light a few candles of realism. They will illuminate practical solutions that will in time make for the critical difference in our planet’s future. It is an exercise well worth the effort.

For more information about this ICASE endorsed event, contact:
Mr Evhan Uzwysyn
Conference Executive Officer
Manitoba Education & Training
Rm 409-1181 Portage Avenue
Winnipeg, Manitoba
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Chemistry in Dance, Drawing, Drama and Daily Life

Zafra M Lerman

Columbia College is an open-admissions, four-year college, located in downtown Chicago where 52% of students are women, 40% are minorities, and 90% come from Chicago inner city high schools, at which they received very little math of science education. Most of our students display a well-developed fear of math and science. They come to Columbia primarily to major in communications and fine arts (Dance, Art, Theatre, Television, Radio, Photography, Film, Journalism, etc).

We decided from the beginning that we would develop a unique Science Department whose goals were to educate students from every major field of study to appreciate science, to enable them to better understand the world around them, to teach them to use science in any endeavour they pursue. The popular media shape our lives and, because our students are entering media professions, by instilling a strong science background in these future media professionals, we are assuring a better understanding of science for the citizens of today and for future generations.

The objectives in all our classes are to make the subject relevant to the students' lives and personal interests, and to their different majors, and to teach the students the scientific method and problem solving. To this end, we incorporate in our classes subjects which deal with the environment, the arms race, nutrition, drugs, health issues, etc. We also try to make the course material interesting enough to foster within each student an active interest in science, which will last even after graduation from college.

We initially had difficulties in obtaining acceptance among both students and colleagues. As a personal example, facing resistance created by students' preset prejudices against chemistry, which had been fostered by a hostile, anti-science attitude in the art and communications faculty, I invited a group of twenty students to a local pub. As the drinks arrived, I initiated a discussion on the composition of the drinks, which developed into an in-depth description of alcohol (ethanol), in its chemical structure and properties. After a lengthy conversation, the students became hungry, so salads were ordered, but I insisted on an oil and vinegar dressing. Vinegar then became the main topic, which led into the structure and properties of acetic acid. The reaction between ethanol and acetic acid was described and the resultant product, nail polish remover (ethyl acetate), was explained. The students were fascinated by this explanation, despite initial fears that nail polish remover was being formed in their stomachs (a reaction which would require a catalyst). After three hours of discussion, I then pointed out to the students that they had just participated in, and enjoyed, a chemistry class. Since our semester lasts fifteen weeks, I told these students that they only had fourteen classes left, if they immediately enrolled in the chemistry course. Most of them signed up.

After the first semester, there were no problems attracting students to take this chemistry class entitled "Chemistry in Daily Life"; word-of-mouth rapidly spread among the student body of an interesting chemistry course being offered.

To help students relax in their first chemistry class, they are told that if they feel completely saturated during a lecture they should hold up a sign that says "saturation", meaning they can absorb no more information. Students are reminded of their experience of dissolving sugar in coffee or tea - after the solution is saturated, the excess sugar settles on the bottom of the cup.

To explore the chemical phenomenon of saturation, students are given a beaker of water and asked to slowly add table sugar. Everyone observes that the sugar dissolves, and the analogy is drawn to their ability to retain ("dissolve") lecture material. As they continue to add sugar, they reach the point where the sugar no longer dissolves - this is defined as the saturation point. These saturated solutions are heated on hot plates and the students observe that additional sugar will dissolve in the heated solutions. The students are asked at this point if raising the temperature in the room will help them absorb more material. (When the laughter dies, we conclude that the analogy doesn't stretch quite that far.)

At the conclusion of this experiment, the topic of crystallization is investigated, and students who suspend a string in their sugar solutions can return to class the following week, examine the crystals that have formed, and indulge in the pleasure of eating the results (rock candy).

This coursework then continues by addressing the social issue of nuclear power, which starts with a discussion of the structure of the atom, atomic orbitals, the chemical bond, and examples of ionic bonds and covalent bonds. The discussion continues with the nucleus, radioactivity, fission, fusion, the development of the atomic bomb and the hydrogen bomb, and ends with an examination of the science, technology and environmental effects of nuclear power plants. Under the title of Acid Rain, we discuss acids and bases, salts, pH indicators and titrations. Students are asked to bring in samples of their own shampoos, and soil from their houses and gardens, to analyse the pH. Rain samples are also collected, and we try to detect any differences in acidities from different areas on different dates.

When we consider nutrition, we talk about proteins, hydrocarbons and DNA, then synthetic polymers, and we continue by discussing fertilisers, foods, food additives, household chemicals, cosmetics and drugs, as well as the chemistry of muscles in sports and dance. Most of these
topics are accompanied by relevant lab experiments and demonstrations. To keep the class material up-to-date, students are asked to bring in articles from newspapers on the subjects being covered, and to present these articles in class.

Chemistry in Daily Life was the first chemistry course we offered and, after the students expressed a tremendous interest in the variety of covered topics, we began to branch out and offer courses on specific subjects as general chemistry, organic chemistry, forensic chemistry, biochemistry, analytical chemistry, etc. To generate student interest, these courses were given attractive titles such as The Science of Nutrition; Energy and the Planet Earth; Human Involvement and the Environment; Lifesavers or Killers: The Story of Drugs; Scientific Investigation: From Sherlock Holmes to the Courtroom; Chemistry of Living Things; Chemistry of the Human Body; Modern Methods in Science: Discovering Molecular Secrets; The Science of Art and Color; Science, Technology and Ethics; Science and Social Issues; and Scientific Issues Behind the News. We continue adding to our curriculum to meet student demand.

All these courses are taught from the economic, environmental, societal and ethical points of view, and as such are made very relevant to the students' lives and interests.

As part of the requirements in each of our courses, students working as individuals or in groups must complete projects on scientific (or science-related) topics, and present them to the class using the tools of their majors. Creativity and originality are strongly encouraged, and students incorporate not only their skills and talents into these projects, but their personal interests and hobbies as well.

A music student presented a paper on "The Chemical Elements Used in Making Strings of Musical Instruments". In order to demonstrate his topic, he built some primitive instruments and played them for the class. Another student studying music and poetry prepared a project on depression and anti-depressant drugs. He wrote it as a poem, set it to music, and presented it to the class, accompanying himself on the guitar.

Students majoring in art use their talents by presenting their projects as a lecture invariably accompanied by some artwork. One student presented his lecture on chemical and physical defense mechanisms employed by fish alongside a colorful poster (Fig.1). Another accompanied her lecture on AIDS with a poster titled "AIDS: The disease doesn't care who you are" (Fig.2).

Another art student made an extremely creative multi-media sculpture which demonstrates the excitation and flow of anthropomorphised electrons through metal wire (Fig. 3).

A student cartoonist created a comical "soap opera" which personified electrons and told of the intricate lives and relationships they lead during chemical bonding (Figs. 4, 5).

Students make polyurethane in a regular laboratory experiment in the Chemistry in Daily Life Class; many creative students mould the polyurethane, while still pliable, into various amusing and inventive shapes.

A videotaped project titled "Early Afternoon with David Foltman" (based on a popular American Night-time television program), was a comical talk show interview with a "famous bond expert" who discussed the human skeleton. Another student incorporated his love of sports in his project, which explores both the materials used in baseball construction, as well as the physics involved in different baseball pitches. "Acetylcholine - The Motor Neurotransmitter" was a videotape on the chemicals involved in muscular reactions. A group of television students presented a project which takes a humorous look at the different sciences involved in forensic crime-scene investigations.

A group of theatre students presented a project explaining the periodic table, the metallic and non-metallic elements, atomic orbitals, and the ionic bond. The project, presented as a Shakespearean tragedy, was entitled "Sodium and Chlorine: A Love Story". The students wrote the script, memorised it, and performed it in front of the class - a fascinating chemistry project and an amusing love story. A group of dance students choreographed Mitosis, illustrating replication and separation of the chromosomes. This dance was videotaped by television students.

Another art student presented a lecture on fusion and Einstein's theories, accompanied by a large painting. Another student presented her paper on Einstein's theories and how they were interconnected with the principles of the universe. Along with her paper, she presented a multi-media sculpture with a picture of the universe behind a portrait of Einstein.

This creative approach to science was demonstrated this year by a poetry book written by a very famous chemist and Nobel laureate, Roald Hoffman, in which he communicates science through poetry. One of his poems, Man and Molecules, very effectively illustrates how poetry can be used in science:

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ICASE Endowment Fund

Associations and individuals are invited to contribute to this fund to support the activities of ICASE.

Contact the Honorary Treasurer of ICASE for further details.
Figure 1  Defense Mechanisms in Fish

Figure 2  AIDS - The disease doesn't care who you are

Figure 3  Visual Concept - Electricity in a Wire - Multimedia Sculpture
...With the molecules of magnesium and oxygen...

John is an electron that lived on the valence shell of the magnesium molecule along with his brother. Now... they were no more.

On the oxygen molecule everyone was happy except, they felt incomplete...

Don't it feel like something missing...?

The valency of the oxygen molecule is 2, and needed only 2 more to become just like the noble gas neon.

However, magnesium had a valency of 2, and following the octet rule of 8, didn't need the 2 electrons electrons in its outer shell...

But suddenly one day...

MAGNESIUM WASN'T HAPPY...

They read the book, they looked outside... a little girl was running.

And magnesium gave up the electrons to oxygen making magnesium oxide...

The theory is that the elements on the left (metals) of the table tend to give up electrons to the elements on the right (non-metals) of the table. The crystal solids are held together by the attraction of oppositely charged ions... this attraction is called...

**IONIC BOND**

...and magnesium gave up the electrons to oxygen making magnesium oxide...
Cantilevered methyl groups, battered in endless anharmonic motion. A molecule swims, dispersing its functionality, scattering its reactive centres. Not every collision, not every punctilious trajectory by which billiard-ball complexes arrive at their calculable meeting places leads to reaction. Most encounters end in a harmless sideways swipe. An exchange of momentum, a mere deflection. And so it is for us. The hard knocks must be just right, the eyes need to be opened, and glimmers of intend penetrate. The setting counts. A soft brush of mohair or touch of hand. A perfumed breeze. Men (and women) are not as different from molecules as they think. (Hoffmann, 1987)

In answer to survey questionnaires, the projects are invariably rated as the students’ favourite segment of the courses, because each student feels they can apply their talents and interests to the course material, and they always enjoy the experience.

We used these teaching methods in levels kindergarten to adult, and in settings ranging from formal to informal, and have always had the very best success. We feel that these methods closely follow the late I I Rabi’s (Nobel laureate in physics) description of how science should be taught: “Science is an adventure of the whole human race to live in and perhaps to love the universe in which they are. To be a part of it is to understand, to understand oneself, to begin to feel that there is a capacity within man far beyond what he felt he had, of an infinite extension of human possibilities .... I propose that science be taught at whatever level, from the lowest to the highest, in a humanistic way. It should be taught with a certain historical understanding, with a certain philosophical understanding, with a social understanding, and a human understanding in the sense of the biography, the nature of the people who made this construction, the triumphs, the trials, their tribulations.” (Rabi, 1972)

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About the author
Prof Zafra M Lerman is Chairperson of the Department of Science, Columbia College, Chicago, USA. This article, so typical of the author’s creative approach to the teaching of chemistry, has been reprinted from the 1989 ICASE Yearbook “Science Education and the Quality of Life” on the occasion of Prof Lerman receiving the National Catalyst Award in recognition of her distinguished career in the teaching of chemistry. Prof Lerman is an active supporter of ICASE activities and Columbia College Chicago is an Institutional Member of ICASE.

1988/89 CASTME AWARDS

First Prize
No first prize was awarded

Second Prize
Murugiah Atuphanathan (Seychelles) Developing a teaching sequence for the theme biosphere for lower secondary science in the Seychelles

Joint Third Prize
Mrs Ann Glover (Zimbabwe) O-level ecology project: a teaching aid for science in the Zimbabwe O-level syllabus
Mr A Christie (India) Save your waits, save your money

Commendations
Ms Desiree Coleiro (Malta) A textbook and teachers’ guide for primary environmental education
Mrs Lee Lee Tee (Malaysia) Biological utilisation of wastes for the cultivation of mushrooms
Mr Ramanlal Hiralal Gujar (India) An examination of mathematics deficiencies of pupils in the first standard by observation of tests

You are what you eat
This has a whole new meaning if you’re a caterpillar. A biologist at the University of California, Davis, recently discovered that Nemoria arizonaria caterpillars, which hack in the spring and feed on an oak’s male flowers or catkins, soon take on catkins’ fuzzy, golden appearance - even down to rows of dots on their backs resembling catkin pollen sacks. In contrast, Nemoria arizonaria hatchling in the summer after catkins are gone look like greenish-grey oak twigs - a result of tannins in the leaves that they eat. This is the first known case in which diet alone dramatically affects an insect’s appearance.

From “Science Notes” Newsscience Vol 14 No 2, a publication of the Ontario Science Centre
250 teachers, including delegates from England, Scotland and the Netherlands, attended the 29th Annual General Meeting of the Irish Science Teachers Association at St Enda's College, Galway, 6-8 April 1990.

The broad and diverse program included the following sessions:

John Foeman, an environmental scientist and historian who is best known for the television series "Exploring the Landscape" presented a session on The science and magic of bogs which examined the fascinating spectrum of Ireland's bogland heritage, its importance, and its role in the teaching of science.

Dr Emer Colleran, lecturer in microbiology at University College in Galway, in her talk on Conserving the Irish environment, focused on the link between development and conservation, the long term benefits to be gained from informed environmental concern, and the role of classroom teachers in helping to create informed concern.

Dr David Thompson from Northern Ireland presented a session on Electronics teaching equipment - just how do you choose? in which he outlined the major criteria for choice of equipment.

Dr Jim Murdoch of Scotland addressed the topic Solving real problems - bringing industry into the chemistry classroom. This session described how materials for Standard Grade Chemistry (a new course for 14-16 year olds in Scotland supported by an Understanding British Industry Project and financed by BP) were produced.

The project focuses on real problems for pupils to solve using a variety of strategies including role plays, practical investigations, and group decision making.

Dr Brendan Keegan, lecturer in zoology at University College, Galway, introduced new hi-tech developments in the area of marine biology during his address Old problems - new solutions.

In his lecture on Corrosion, Dr Liam Carroll, lecturer in physical chemistry at University College, Galway, described simple ways to communicate information using common everyday examples.

Billy Reidy explored in Teaching science in the primary school the opportunities that science provides for developing skills and involving children in their own education.

Jackie Jones, a health educator, addressed a number of issues confronting teachers when dealing with topics related to sex. In her session Sex, science and school ethos, she presented a model to explain how and why topics on sex are treated differently.

The program also included workshops for biology, chemistry and physics teachers, tours and social events.

Many national reports in the United States have suggested that students learn best through programs that provide substantial hands-on laboratory experience. Such programs make science teaching complex and challenging.

The National Science Supervisors Association's LISE Center recently held the first in a series of leadership development clinics dealing with laboratory safety programs.

The Clinic, held in the state of Florida, provided teachers, supervisors and administrators with information and advice on laboratory safety procedures and policies, and helped them to develop pertinent communications and supervisory skills. The objectives of the Clinic were as follows:

- To inform participants of the laws, codes, regulations and accident case
MNU to celebrate 100 years as an association

1991 will be the 100th anniversary of MNU (des Mathematischen und Naturwissenschaftlichen Unterrichts) in Germany. Special celebrations will take place from 24-29 March 1991 at Gottingen, including a meeting devoted to international issues and problems confronting science education. It is hoped that this meeting will lead to similar meetings in other European countries.

The MNU is conducting a survey to determine the amount of time spent on science teaching in schools. It is their belief that this is a useful indicator of the priority given to science education, and the association plans to use this data in order to strengthen the case for a higher priority being given to science education.

The survey form asks respondents to indicate the number of hours per week allocated to integrated science, to biology, to chemistry, and to physics at each age level.

MNU is keen to obtain comparative data from science teachers in other countries. Those willing to contribute to this MNU project are invited to request a survey form by writing to:

Dr Hans-Jurgen Schmidt
Fachbereich Chemie
Universitat Dortmund
Postfach 500 500
4600 Dortmund 50
FRG

The Harare Generator
Zimbabwe, Africa, September 1990

The University of Zimbabwe, in association with the Committee on the Teaching of Science of the International Council of Scientific Unions (ICSU-CTS) will be hosting this meeting to develop Africa-relevant adaptations of educational innovations. The Harare Generator will have the theme "Innovative techniques in science and technology education in Africa". It will be a regional followup to the ICSU-CTS Conference on Science and Technology and Future Human Needs which was held in Bangalore, India in 1985.

A number of African countries have begun to adopt the ideas raised in Bangalore to make curriculum changes in schools, colleges and universities. The Harare Generator will provide an opportunity for African countries to share the results of these developments since Bangalore. It will involve presentations, demonstrations and hands-on workshops by leaders in educational innovation. However, the Harare Generator is not a conference. Participation will be by invitation only.

The aim is to develop a tangible product that can be immediately copied and issued to participants on departure.

This product will be a pack containing:

- proceedings of key presentations
- videotapes of key demonstrations and workshops
- computer disks with samples of software demonstrated or developed during the Generator
- blueprints and prototypes of low-cost equipment demonstrated, designed or built during the Generator
- project proposals and funding awards constructed or negotiated with representatives of Development Aid Agencies

The organisers are keen to find out who are the key, creative people in Africa to contribute. Suitable people would be those using or developing innovative techniques in science and technology in Africa; those with an ability to adapt ideas for trials in African conditions; those in a position to make further progress in such work; and those in a position to disseminate the results of the Generator.

Recommendations for participants should be sent to Mike Robson, Harare Generator, Faculty of Science, University of Zimbabwe, PO MP 167, Harare, Zimbabwe, Africa

For additional information, please contact:

Dr Kenneth R Roy
NSSA LISE Center
Suite 227-228
Copernicus Hall
Central Connecticut State University
New Britain, CT 06050
USA.
UNESCO calls for articles on science education

by John Ellick

The Science Education Section of UNESCO is interested in receiving submissions from science teachers and teacher trainers who would be willing to write short articles (2-3 pages) for UNESCO based on their classroom experience of teaching or observing the teaching of the following topics:

- biotechnology
- bioethics
- marine science
- use of microcomputers in science
- chemistry and energy resources
- chemistry and the environment
- science and technology for rural areas
- educational games for teaching science
- community resources for out-of-school science teaching
- science and technology for women in rural areas
- technology in the basic science curriculum
- science curriculum for self-sustaining economies

The submissions should contain a brief outline of professional experience, and either a summary of a proposed article or an article on that topic already published by that author. Submissions should refer to accounts of exemplary teaching content or method which is an accepted improvement in present educational practice in that region of the world.

Furthermore, the Science Education Section would like to receive expressions of interest from teachers and teacher trainers who would be able to:

- edit a comprehensive guide for using laboratory apparatus and chemicals and safety instructions
- edit primary science and agriculture teachers' guides for schools in tropical areas
- improve illustrations of science and agriculture topics for primary and junior secondary material

Send submissions to Science Education Section, UNESCO 7 place de Fontenoy, 75700 Paris France

Children's Learning in Science Research

The Children's Learning in Science Research Group at the University of Leeds in the UK has been established to bring together researchers, teachers and others to investigate and disseminate ways of improving children's learning. The foundations for the work of the research group have been laid by the work of the Children's Learning in Science Project (CLISP) since 1982.

The central focus of the Children's Learning in Science Research Group is the study of the way science ideas and concepts develop in children from age 5 to 16; and ways of promoting more effective learning in classroom, laboratory and fieldwork settings.

The group is involved in the following research and development projects.

Conceptual change in science project

This project is funded by the Economic and Social Research Council and involves CLISP, the Computer-based Learning Unit at Leeds, and teams from Glasgow and the Open University. The aim of the project is to develop and evaluate computer software that contributes to the process of conceptual change in secondary school pupils in the field of mechanics. The software will be included in classroom teaching and its effectiveness will be investigated in this context.

Science and technology in action project

This project is funded by the British Nuclear Forum. The aim of the project is to develop teaching resources that relate science to a range of social, industrial and economic concerns. Materials are being developed for two topics Energy technology and Food technology for 14-16 year olds.

The materials will encourage decision making involving economic factors, environmental consequences, and social and individual concerns.

National curriculum science support project

The National Curriculum Council has sponsored a project to investigate progression in children's ideas across the 5-16 age range; and act as a resource for studies on progression in science. The project started in January 1990 and will concentrate on understandings of biological concepts.

Further information can be obtained from the Children's Learning in Science Research Group, CSSME, University of Leeds, Leeds LS2 9JT UK.

Reprinted from Science Education Newsletter March 1990

Quantum - a new magazine for students

Quantum, a student mathematics and science magazine, appeared last January, published by NSTA in collaboration with the American Association of Physics Teachers and the National Council of Teachers of Mathematics, and in cooperation with the Soviet Academy of Science. This magazine, to be published in both the USA and the USSR, enables students around the world to share the pleasures and challenges of Quantum's problems, articles and other features.

This is the first of a number of cooperative projects in science education which are to be undertaken by the USA and Soviet organisations.

It is based on material from Kvant, a popular science monthly magazine which has been circulating in the USSR for the past 20 years.

The magazine contains recreational material, lively illustrations, humour and amusing anecdotes from the history of science. Articles in physics and mathematics require hard thinking in order to be understood, and the problem corner is intended for those who like Olympiads and other problem solving competitions.

For more information, write to the Editors, Quantum Magazine, 1742 Connecticut Avenue NW, Washington DC 20009, USA.
The Effects of STS Instruction on Student Learning

by Robert E Yager

Science Technology Society (STS) is defined broadly using the definition advanced by the STS Initiatives Task Force of the National Science Teachers Association.

"STS represents an appropriate science education context for all learners. The emerging research is clear in illustrating that STS experiences result in students with deeper concept mastery and ability to use process skills. All students improve in terms of creativity skills, attitude, use of science concepts and processes in their daily living and in responsible decision making."

"There are no concepts and/or processes unique to STS; instead STS provides a setting and a reason for considering basic science and technology concepts and processes. STS means determining ways that these basic ideas and skills can be seen as useful. STS means focusing on real-world problems instead of starting with concepts and processes which teachers and curriculum developers profess to be useful to students." (NSTA, 1990)

In STS classes, students and teachers are active learners. Students often identify their own problems and strategies for solutions. Teachers work with students on projects; they are not holders of all knowledge. Typically, student problems involve their communities, including the people. Iowa students have studied the impact of local airports, water pollution, sewage treatment, and care of the elderly.

Nearly 1500 teachers from every level, K-12, have participated in the Iowa STS Chautauqua Program since 1983. This program helps teachers develop goals, strategies, materials, and assessment efforts appropriate for integrating the teaching of Science Technology and Society. Since 1983 nearly 5000 students have experienced one or more STS modules and have participated in assessment efforts designed to determine the impact of such instruction. The Chautauqua in-service model includes:

- A one-week leadership conference during which teachers who have tried and succeeded with STS are prepared to assist with instruction; leaders from industry, college scientists, area supervisors, and school administrators also participate.
- A two-week summer workshop for 30-50 new teachers who are attracted to STS and possible improvements in their teaching and in their selection of materials. The staff team consists of experienced teachers from the leadership conference.
- A two-day fall short course which follows a five to ten day trial with the STS module planned during the summer. A similar staff is involved. Half the time is spent on assessment strategies.
- Contact is via mail, telephone, and in-school visits between the fall and spring short courses for encouragement support and assistance.
- A two-day spring short course for sharing teaching experiences, reporting of assessment efforts, identification of most successful teachers for new leadership, and discussion of next step strategies.

Assessment of student growth following STS instruction is basic to the Iowa Chautauqua Program. Assessment has used the five domains of science education proposed by Yager and McCormack (1989). These domains include (1) concept mastery (2) use of science process skills (3) attitude toward science, science classes, science teachers, science careers, and usefulness of science study (4) creativity skills, including questioning, proposing causes, and predicting consequences (5) applications of concepts and connections to the lives of the students.

Several reports of student growth with STS as defined by NSTA and as taught by teachers who have experienced the Iowa Chautauqua Program have appeared (Yager, 1987; Myers, 1988; McComas, 1989a, 1989b, 1989c, 1989d, 1989e; Yager, 1989a, 1989b; Yager, Myers, Blunk, & McComas, 1990; Yager, in press).

Although first time STS teachers and classrooms show good results, the most striking student growth occurs in classrooms taught by the experienced lead teachers. In many instances these teachers have used STS approaches for five years and have transformed entire courses into STS. Most of these teachers are from classrooms from grades 4 through 9 - the grade levels first targeted in the Iowa program.

Early elementary programs encounter special problems associated with such skills as reading and utilizing resources - both material and human - from the community as a whole. In the high school there are numerous problems focusing on the college preparation of
students, test scores, electives, and concentrations of energies for the brightest students.

Some of the assessment reports have produced dramatic and significant results illustrating the advantages of STS instruction. An analysis of these results in each of the five domains permit the emergence of generalities about the power and advantages of STS for all learners.

Concepts
When concepts are identified prior to instruction as ones likely to be encountered because of the questions and themes which initiate module planning, growth between pre- and post-testing invariably occurs. When STS and non-STS class sections are compared, little difference is noted in terms of the quantity of concepts seemingly learned when using classical testing procedures. Some teachers have achieved statistically significant advantages in favor of the STS sections. Invariably this results from higher scores for average and below average students. Although it is not conclusive, early indications suggest far greater retention of concepts for STS students, presumably because the learning took place in real situations rather than in the typical mode of learning stimulated by teacher urging or the promise of the necessity of recalling the information for examination.

Processes
Most measures of improvement in student understanding in the use of science process skills produce disappointing results, probably reflecting a failure to focus upon mastery of such skills either during instruction or for testing. STS demands the use of most of the process skills in work upon questions and issues raised by students. As a result it is not unexpected that growth in this domain for the most successful STS teachers is statistically significant. In many cases the growth in specific processes doubles the growth observed in non-STS sections taught by the same teacher. STS seems to be a useful and successful way to stimulate students of all abilities to improve in the understanding and use of science process skills.

Attitudes
While traditional science teaching results in students developing a progressively more negative attitude about science, science classes, science teachers, and science careers, this decline is invariably halted with STS. In STS courses taught by the most successful and enthused, student attitude about science is enhanced by a factor of two. One of the major advantages of STS is a dramatically improved student attitude. Such positive reactions are least dramatic for the best students as teachers and schools shift to STS. Conversely, the greatest increases occur for average and below average students.

Creativity
STS focuses upon questions, explanations for given situations, and predictions of consequences of certain actions. Time is spent determining the most useful questions, the most accurate causes, and the most reasonable consequences. Hence it is not surprising that the research reports all indicate that STS is far superior to traditional approaches to science instruction in this domain. For some teachers the quantity of questions, causes, and consequences is not so much greater for STS students when compared to those in traditional classes. However, the quality and usefulness of the responses for STS students is invariably superior - again by a factor of two.

Applications/Connections
For many teachers STS means starting with applications, and for many students STS means a greater focus on applications and connections to their

ICASE AWARD SCHEME
for outstanding contributions to international science education

ICASE Distinguished Service Award
This award is made to individuals who have a career history of distinguished service to international science education through their involvement in the international activities of local, regional and global science education organisations

ICASE Regional Service Award
This award honours individuals who have made a significant contribution to international science education through their involvement in international activities at the local and regional levels

ICASE Association Award
This award recognises individuals who, within their science teacher association, have made a significant contribution to the international activity of their association

Contact Dr Jack Holbrook, Executive Secretary ICASE
Department of Curriculum Studies, University of Hong Kong, Hong Kong

14
real world. It is not surprising then to find the most common and significant advantages of STS instruction to occur in the area of student ability to apply information, to use it in new settings, to connect to the real world.

Interestingly, this holds true for students in the elementary school, where common belief holds that application is a higher order skill, possible only for the most gifted and for those in the secondary school. Third grade teachers report fantastic results with their students applying concepts and process skills in all kinds of situations in the STS format. In summary, STS approaches produce a variety of advantages in student learning. These include:

- The quantity of concepts learned is as great as that found when concepts are given to students and stressed as important to remember in traditional classrooms.

- Emerging evidence suggest that concepts learned in an STS setting are retained longer and are more useful.

- Student attitudes about science, science teachers, science classes, and science careers are enhanced by STS.

- Creativity skills (quantity and quality of questions, probable causes, and possible consequences) are enhanced by STS instruction.

- STS instruction produces students who can apply science concepts and process skills; they can connect their learning to the real world around them.

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Robert E Yager is Professor of Science Education, Science Education Center, University of Iowa, Iowa City, USA

Do you like loud headphone music?
If you do, you're in danger of damaging your hearing. But now there's a new product to reduce the risk. The headphones developed by a British electronics company will shut off if they are played too loudly. Inside the phones is a pair of diodes that continuously monitors the level of the incoming signal and compares it to a preset threshold of 92 decibels - that's about the level of sound that would come from a home hi-fi turned up loud.

If the incoming signal exceeds the threshold, the diodes cut it off before it reaches the speakers. As soon as the listener turns down the sound to a non-dangerous level, the headphones start working again.

Pasteur and Microbes
A Teacher Resource Book
Commemorating the 100th Year of the Pasteur Institute 1888-1988

This valuable resource book (166 pages) provides information about the activities and facilities available at the Pasteur Institute. It also contains a variety of science experiments relating to the action of soil microbes, yeast as a food-making microbe, micro-organisms in milk, making cheese, making vinegar, and making wine, to name just a few. These activities are appropriate for secondary science teaching. Emphasis is on useful micro-organisms, food production and food preservation.

Available from ICASE
See Resources for details of how to order
Building & Assessing a Teaching Rationale

Ronald J Bonnstetter & John E Penick

Teachers who only know what to do and how to do it will always be led by those who know why they are doing it. Helping students create a research-based rationale for the why can be a valuable preservice program outcome.

The culminating methods class activity at the University of Iowa and the University of Nebraska involves writing a rationale paper and defending its content during a lengthy one-on-one exit interview. In this 10 to 12 page paper students include comments justifying why they will do what they describe and to include research support. Some aspects of their teaching addressed include:

- Why you will teach science
- What your goals are for your students
- What your materials will look like
- What your students will be doing in the classroom (be specific)
- What you will be doing in the classroom (be specific)
- How you will evaluate your program
- Several sample lesson plans
- List of references

Instead of having a final paper and pencil test, students are scheduled into 90 minute exit interviews where they defend their present views of teaching. In the process many reach new levels of understanding and commitment.

The following represent examples of questions that have been used. The final direction and actual questions are determined by a review of the student’s rationale paper and other work handed in during the semester. The interview focuses on the how, not just the what. This is a very important concept for the interviewer to keep in mind. Many times preservice teachers will have a goal but will have little or no idea as to how that goal will be met. For example, if the student says "I will allow my students to be creative", the interviewer must ask and seek the answer to the question “What will you do that will allow your students to be creative?” Other examples of rationale defense questions include the following.

How does your rationale now compare with the beginning of the semester? What is the most important goal that you have for your students? What are your major concerns as you prepare to become a teacher? If you could change one thing in education, what would it be?

How would you define curriculum? What influences what goes into a curriculum? What are the major components of a curriculum? If you could design your own curriculum, what would it look like?

What is the role of the teacher? What does the ideal teacher look like? What are the characteristics of a good teacher? What do you consider to be your greatest strengths as a teacher? What are your weaknesses at present? If I walked into your classroom, what would I see? What will you be doing? How will you evaluate your teaching?

What is science? How would you define the difference between science and technology? What role would science/technology/society issues play in your classes? Why? What percent of time? What would such a class look like? How would you teach for scientific literacy?

How would you rate the importance of developing a positive student attitude towards science? What would you do to enhance this goal? What would you do to enhance the development of critical thinking skills? How would you know if this goal had been accomplished?

Define teaching strategies. What are the main teaching strategies or teacher behaviour that you plan to use on an everyday basis? How often will you lecture? Why? What percent of the time? Describe how you would run a discussion? What, if any, are the differences between an open-ended lab and a hands-on lab? What does an open-ended lab look like? How would you use computers in your teaching? How would you use a film in your teaching? What components of your teaching strategies would you want present in every class period?

How will you evaluate your students? Would you give a pretest? Why? How would you use the results?

How will you handle classroom management? What are the rules for your class?

How will you use research related to how children learn in your teaching? What assumptions are you willing to make about the students that come into your class? What does research say about the sequence for effectively teaching a new concept?

What is the purpose of getting involved in professional organisations?

How did you feel about this session? What questions do you have of me? What grade do you deserve for this course and why?
Having a rationale means that a preservice teacher not only knows what and how to teach but why. Such a teacher is prepared to defend their curriculum and teaching and to influence others. In addition, the teacher with a rationale is less likely to forget their sometimes idealistic notions about teaching and will continue growing and learning as teachers.

About the authors
Ronald J Bonnstetter is Director of Secondary Science Education at the Center for Curriculum and Instruction, University of Nebraska, Lincoln, Nebraska, USA. John E Penick is Professor of Science Education at the Science Education Center, University of Iowa, Iowa City, Iowa, USA.

CONTRIBUTIONS WELCOME
to
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Send your contribution to the Editor or to the Editors of the sections:
Research on Teaching and Learning (John E Penick)
Science Teacher Education (Ronald J Bonnstetter)
Primary Science (Sue Dale Tunnicliffe)
Science Technology Society (Maris Silis)

More on Science Teacher Education

Postgraduate Certificate in Environmental Education
Jordanhill College, Glasgow, in association with the World Wide Fund for Nature (UK), has introduced a new modular environmental education course for teachers from overseas. It is a three month postgraduate course for experienced teachers, teacher trainers and curriculum developers either within schools or in higher education. The course consists of four modules:

- planning and process
- theory and practice in environmental education
- curriculum, school and community
- independent study

The first module is compulsory and the fourth will be integrated within the other modules. Students will have to complete a practical study project to produce a curriculum design package suitable for use in their home country. The satisfactory completion of this will be essential for the award of a certificate.

Further information is available from Director of Overseas Courses, Jordanhill College, Southbrac Drive, Jordanhill, Glasgow G13 1PP, UK. 
From Science Education Newsletter March 1990

Chemsource Project
The Chemsource Project, funded by the US National Science Foundation, is being developed by the Committee on Education of the American Chemical Society. The project aims to provide detailed support for inexperienced secondary school chemistry teachers, pre-service teachers and in-service chemistry teachers during their first three years of teaching. The two major features of the project will be Sourcebook and Sourceview.

Sourcebook is a resource being prepared by eleven regional cluster groups of high school and university teachers of chemistry. It will provide teaching tips and instructional ideas relating to over thirty topics commonly taught in the high school curriculum. It will also contain laboratory activities, demonstrations and common misconceptions.

Sourceview will use video and other technologies to introduce inexperienced teachers to successful learning strategies related to laboratory and classroom instruction and management.

Both Sourcebook and Sourceview are being developed and piloted over the next three years. Further information is available from Mary Virginia Orna, Department of Chemistry, College of New Rochelle, New Rochelle, NY 10801, USA.

From Science Education Newsletter March 1990

Video Network Project
The Finnish INISTE network has set up a videotape exchange project, which involves the development of videotapes on methods of teaching, application of various learning theories, new ideas for practical work, and comparing varying styles amongst teachers.

For further information, contact Maarit Rossi, Karhutie 9, SF-02400 Kirkkonummi, Finland.

From Information Bulletin INISTE Vol VI No 1 1990
Primary Science

Section Editor
Sue Dale Tunnicliffe
ICASE Project Officer
18 Octavia, Bracknell
Berkshire RG12 4YZ
UK

Teachers Notes
Most children meet this challenge by making a magnifier using (1) a piece of card with a hole in it, or (2) a piece of wire with a small loop to hold the water. The loop needs to be dipped into water so that a film is formed across the loop. If the card is used, the hole can be made by a pencil point or the sharp end of a safety pin. Remind children about the safe use of the pin, that they should pierce the card while it rests on a surface or pad of paper, and that it should be closed as soon as they have made the hole.

The card/paper needs to be waterproofed by rubbing a candle or wax crayon across the surface. A hair clip makes an ideal holder for the water drop. An unbent paper clip or piece of wire will do just as well if the children can form a small enough loop.

Using thinking triggers can be helpful in the initial discussion, for example pictures of steps in making a paper clip loop, or steps in making a hole in a card and then covering the card with wax. Better still, collect the various items of equipment and let the children handle them while discussing the challenge and planning their solution.

One technique for "measuring" the amount of magnification or reduction is to draw the object without the drop, and again when viewing through the drop, and comparing the drawings.

Usually the children will see that the drop magnifies the viewed object, but sometimes they will notice that, in certain positions, the object is smaller and upside down.

Lead the discussion onto a teaching point about magnifying glasses and the properties of lenses if this is appropriate for the age group you are teaching.

Water as a magnifier
Here is an activity for your pupils to try. Stepping into Science involves children in the following steps:

- Planning their investigation
- Choosing equipment to use
- Carrying out their investigation
- Recording their observations and measurements
- Communicating their findings to a wider audience

Challenge
What happens if you look through a drop of water?

Discussing
Ask have you ever looked through water? What do you see when you look at something through a glass of water? Have you ever looked at something on the bottom of a dish or pan full of water? What happens if you reach for something you see on the bottom of the bath? Refer to the activity about water drops on page 17 of the March issue of Science Education International.

Planning
Ask where this investigation will be carried out. Inside, outside, at a sink? How will they make a drop? Will the drop be put on paper, or held in a holder? What will they look at?

Choosing equipment
Ask what equipment they will need. They may need a container for water, a paper clip with a loop in one end, a piece of paper with a hole in it.

Doing the activity
Do pupils change their plan as they do the activity? Once they have looked through the drop, do they change what they planned to do?

Recording
What observations are they making? Can anything be measured?

Evaluating
Did their plan work? What did they see? Is this what they expected? What have they found out?

Communicating
How will they share their findings? Children are welcome to send a report to Sue Dale Tunnicliffe, ICASE Project Officer for the Stepping into Science Project.
4th World Exhibition of Young People's Inventions

by Maris Silis

Introduction

Throughout the world many societies are actively encouraging and fostering the development of creativity and inventiveness in their younger members. These societies recognise that creative individuals, and communities that value originality and creativity, are essential for desirable economic and social development.

In 1991 a World Exhibition will provide opportunities for students from around the world to display the products of their inventiveness and to develop international understanding and friendship.

Japan Institute of Invention & Innovation

The Japan Institute of Invention & Innovation (JIIN) has a long history of providing encouragement, information and help to inventors (JIIN, 1989a). Since 1941 it has, among other things, hosted an annual "Concourse of Schoolchildren's Inventions" for Japanese students. In 1972, 1975 and 1985, World Exhibitions were organised. Figure 1 displays the 30 countries which contributed a total of 161 entries for the 3rd World Exhibition in 1985.

The JIIN now invites submissions of appropriate "devices of invention and innovation" for the 4th World Exhibition of Young People's Inventions to be held in Tokyo in 1991.

Figure 1 Countries participating in 3rd World Exhibition 1985

Key Details

- Entry is open to girls and boys born between 1 January 1972 and 31 December 1980 inclusive.
- Applicants must construct and submit a device. Drawings or descriptions alone, are not sufficient.
- An official entry form must be submitted by 30 June 1990.
- Upon receipt of the completed entry form, the JIIN will provide instructions about how devices should be sent to Japan.
- There are no application fees or transportation costs for devices.
- Devices will be displayed in Japan between March 1991 and March 1992.
- A Commendation Ceremony will be held in March 1991, and selected applicants will be invited from different countries. In 1985, three applicants, plus their guardians, from different countries were invited.
Examples of students’ work

In 1985 entries for the World Exhibition included an automatic slide projector; a computerised boomerang tracker; a battery based upon the action of bacteria; a device for pressing wooden sheets; a solar water heater; a talking watch for blind people; an alarm activated by vibrations or other changes in the environment; a set of straight and curved blocks which can be used in various combinations to make park benches, steps, etc; a device that retrieves metallic objects such as needles from a carpet; a punch card robot; a savings box; a hydrogen producer for fuel; and a tuner for musical instruments. Other devices are shown in the following photographs.

Rat-Repulsing Apparatus
Igor Zachar (17 years) Czechoslovakia
The concept of this device is derived from the fact that rat catchers used to use whistles to drive away rats. A part of a phone receiver is used to emit a sound of a certain frequency which is irritating to rats in order to drive them away.

Safety Socket
Xiu Chen (12 years) China
This socket is designed to prevent electrical shock when plugging or unplugging a cord. When a plug is pulled from the socket, the openings of the socket are closed because of a valve which is opened or closed by a spring inside the socket.

Telephone Extension System
Roberto Ramon Castro Garcia (19 years) Peru
In this invention, three telephones are connected to one line, each of them functioning independently. An incandescent electric lamp is attached to each of the receivers and its ON or OFF state indicates the state of usage of the other receivers.

Electricity from Wind
Rajeshore Vaidya & Atendra Lal Shrestha (both 16 years) Nepal
This invention consists of a fan, a generator and a storage battery. When the wind blows, the fan revolves and the revolution is transferred to the generator while the generated electricity is stored in the battery.

Tool for Stripping Insulation
Katarzyna Kimmel (18 years) Poland
This tool easily removes the vinyl insulation from wire. The angle of the peak of the edge is 20 degrees. The insulation is removed easily simply by making a slight cut in it and pulling it off.
Potential benefits

There are many personal benefits for student inventors. Identification of a need or problem, and the designing, construction, evaluation and modification of a device can help develop many desirable skills and attitudes such as those discussed by Gilbert (1987).

Students learn that finding and solving real problems involves much more than following directions provided by a teacher or published in a book. Blind alleys, lack of knowledge and skills, and competing demands for time are just a few of the obstacles that may need to be recognised and overcome.

Scientific knowledge must be combined with other kinds of knowledge and skills. Judgements may have to be made about aesthetic and economic aspects of a device as well as about its functional capabilities. Students can develop communication skills and also attitudes such as confidence, perseverance, self-criticism and, most importantly, willingness to "have a go".

The skills and attitudes referred to above should also help students cope with other problems and to participate more fully and productively in modern society. Society, in turn, benefits from the collective talents of its members.

The World Exhibition also promotes scientific, technological and cultural exchange, the strengthening of ties of friendship and the development of better understanding between participating countries.

Further details

Further details and entry forms are available from:

JAPAN INSTITUTE OF INVENTION & INNOVATION
9-14 Toranomon 2-Chome, Minato-ku
Tokyo 105, Japan
Tel: Japan 03-502-0511
Fax: Japan 03-502-1480

References

Gilbert C 1987 A guide to primary technology policy
Edinburgh: Oliver & Boyd

Japan Institute of Invention & Innovation 1989a Guide to activities concerning commendations, exhibitions and projects to encourage creativity Tokyo: JIII

Japan Institute of Invention & Innovation 1989b 1985 Exhibition and excellent devices Tokyo: JIII

About the author

Maris Silis is Senior Lecturer at the Salisbury Campus of the South Australian College of Advanced Education. At the October 1989 ICASE General Assembly, he was elected Australasian-Pacific Representative on the ICASE Executive Committee.

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Women inventors - how many can you name?

Inventors? There are greats like Leonardo, Galileo, Franklin, Morse, Bell, Edison, but can you name one female inventor other than Marie Curie? Not easy, is it!

Research, however, suggests that women were inventors from the beginning, introducing everything from cooking and pottery-making to weaving, tanning, hut-construction and crop-raising.

Prior to about 1800, women had trouble getting recognition as inventors because they were not allowed to own patents. Even when they could, some women would simply share their inventions with friends or freely publish their findings. Such was the case with Marie Curie, the only person ever to win two Nobel Prizes (1903 and 1911). Refusing to patent for gain, Curie "discovered" radium, invented a process for extracting radioactive material from uranium ore and created the prototype of what is now known as the geiger counter.

When women extended their workplace and education, their inventions changed accordingly. Munitions work during the Great War resulted in weaponry patented by women - an automatic pistol, a bomb launcher, an incendiary ball, a railway torpedo, a front sight for firearms, a submarine mine, and others.

More recently, Stephanie Kwolek invented Kevlar arimid fibre used in radial tyres and bulletproof vests; Dr Marguerie Shue-Wen Chang invented a trigger mechanism for underground nuclear testing; 3M employee Patsy Sherman co-invented Scotchguard; Barbara Askins won the US National Inventor of the Year Award for creating a way to obtain clearer pictures from old negatives.

Over the years, many female inventors have been overlooked. Lady Mary Montagu introduced smallpox inoculation to Europe in 1717, 80 years before British physician Edward Jenner. Madame Lefebvre of Paris patented the process of making nitrate fertiliser out of nitrogen gas as early as 1859, 50 years before the world was ready to "re-invent" her idea.

Martha Costin's signal flare helped the North win the Civil War, but it became known as the "very pistol" after Lieutenant Very patented a very small improvement to it. Nuclear fission was discovered and named by Dr Lise Meitner, providing world powers with the "ammunition" to develop the A-bomb that ended World War II. Yet it was her male colleague who received the Nobel Prize in 1944.

Adapted from Newscience Vol 14(2)
Apollo 11: Commemorative Issue

This book (184 pages) commemorates the twentieth anniversary of the Apollo 11 Moon landing (1969-1989) and is intended as a teacher resource. It provides background information and activities for both elementary and secondary science students. In addition, it offers multi-disciplinary activities that can be used in Language Arts and English.

The teacher resource book has been compiled and edited by Linda W Crow and Donna L Hare, and published by I CASE as the latest in the series of commemorative issues. This valuable resource is available at a cost of US$10.00 or £6.00 from I CASE (see I CASE Publications in this section).

The Greenhouse Effect: Exploring the Theory

This activity book, published by CSIRO Australia in 1990, is for 11-16 year olds. It is a rich and useful source of ideas for teachers working with primary and secondary students who enjoy learning from direct experience. There are activities suitable for classroom situations, and others for individuals. The examples are Australian, but the activities are appropriate for classrooms in any country. An information page, photos, graphs, maps and tables appear before each set of activities. These lead the greenhouse explorer through aspects of the greenhouse theory and put the activities in perspective. The activities develop skills needed to better understand atmospheric and climatic change. With these skills, students will be able to critically evaluate the information, opinions and arguments concerning environmental and climatic issues. Chapters include greenhouses and the greenhouse effect, how are we affecting the Earth's atmosphere, sea level changes, climate changes, engineering changes, farming changes, changes in our daily lives. This book is available (A$9.95 plus postage) from CSIRO Publications, 314 Albert Street, East Melbourne, Victoria 3002, Australia.

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Bibliography in Integrated Science Teaching

This book, compiled by Judith Reay, is No 36 and the latest in the Document Series on Science and Technology Education published by UNESCO. It is an annotated bibliography which samples publications from 1978 to 1988. The book uses the term "integrated science teaching" in its broader sense, covering topics such as science technology society education, and environmental education. Levels include primary, secondary, higher, vocational and teacher education.

The bibliography contains more than 370 entries which are arranged chronologically by year of publication. Each entry contains an annotated description of the subject and a set of keywords which are used in the subject index.

The bibliography is an attempt to meet the needs of educators worldwide, and therefore aims to represent as many local publications as possible, together with a selection of internationally known items. Only English language publications have been included. This publication is available from the UNESCO Division of Science Technical & Environmental Education, 7 place de Fontenoy, 75700 Paris, France.

Science and Technology in School Curricula Series: Case Study 5 Pakistan

UNESCO has recently published this latest case study, which focuses on (1) the place of science, mathematics and technology in the curricula of primary and secondary schools (2) the content of SMT curricula (3) the content of courses in integrated science and a summary of the content of the separate sciences courses (4) the Ministry of Education policy on the place of technology education in primary and secondary schools. It is available, free of charge, from Documentation and Computer-Assisted Management Service, Education Sector, UNESCO, 7 place de Fontenoy, 75700 Paris, France.
ICASE is keen to arrange regional or world events for the benefit of member associations. If your association or organisation is interested in hosting an international seminar, workshop or conference, contact the Executive Secretary or your Regional Representative. To gain ICASE endorsement, the meeting must be international in nature, open to member associations, and, while all sectors of the science education community should be encouraged to participate, must be relevant to classroom teachers.

1990

June 6-8
ICASE Europe Research Seminar
Location: University of Dortmund, Dortmund, F R Germany
Contact: Prof Dr Hans-Jurgen Schmidt, Department of Chemistry, University of Dortmund, Otto-Hahn-Strabe, D-4600 Dortmund 50, F R Germany
The theme of this research seminar is "Empirical Research in Science and Mathematics Education". The aim of the seminar is to discuss the methodology of empirical research in this field. Approximately twelve 40 minute papers will be presented (in English) and then discussed. A proceedings will be printed and available through ICASE.

June 7-9
Second European Conference on Health Education
Location: Warsaw, Poland
Contact: Mrs M A Modolo, Europe Office, Centro Sperimentale per l'Educazione Sanitaria, Universita di Perugia, CP 35 PG 3, Via del Giochino 4, 06100 Perugia, Italy
Organised by the European Region of the International Union for Health Education, this conference will focus on young people as the target group. Innovative educational approaches will be introduced to improve communication and the quality of health education. During the conference, a competition organised particularly for secondary school pupils, based on their own interests (environment, school life, community) will take place.

June 25 - 29
International Symposium on Evaluation of Physics Education: Criteria, Methods and Implications
Location: University of Helsinki, Finland
Contact: Prof V Meisalo, Department of Teacher Education, University of Helsinki, Ratakatu 2, SF-00120 Helsinki, Finland
This symposium, organised by the Teaching Section of the Finnish Physical Society in cooperation with the Department of Physics and the Department of Teacher Education at the University of Helsinki, aims to provide a forum for presenting and discussing new ideas for the goals, content, means and evaluation of physics education.

June 25 - July 6
Second International Workshop on New Technology Course Materials
Location: MEDC, Paisley, Scotland, UK
Contact: Dr Peter Williams, Director, MEDC, 8/14 Storie Street, Paisley PA1 2BX, Scotland, UK
This cooperative workshop will develop materials for the new technologies. Groups from different institutions and countries will select topics of common interest on which to produce computer aided learning packages, videos, open learning or other appropriate materials. All resulting materials from all groups will belong to all participants.

July 4-6
ASPEI Regional Workshop II on Conceptual Structures and Change in Physics Learning
Location: Quezon City, Philippines
Contact: Dr Vivien Talisayon, ISMED, University of the Philippines, Diliman, Quezon City, Philippines

July 9-13
CONASTA 39 Annual Conference of the Australian Science Teachers Association
Location: Alice Springs, Northern Territory, Australia
Contact: Peter Deacon, Convenor, CONASTA 39, PO Box 705, Alice Springs NT 0871, Australia
The CONASTA 39 Theme is "Science Education and Technology for the 90's". The Conference will provide a forum for science educators to examine important issues confronting us in the new decade. The program includes keynote addresses, practical sessions, excursions and social events. This is an ideal opportunity for visitors to experience the world renown attractions of central Australia.

July 9-14
NASA Space Science Seminar and Workshop
Location: Houston, Texas, USA
Contact: Evhan Uzwheshyn, Science Consultant, Manitoba Education, 409-1181 Portage Avenue, Winnipeg, Manitoba, Canada R3G OT3
This program for selected Canadians and up to 10 international delegates includes lectures by NASA researchers, and an extensive program of visits to facilities such as the site research and testing facility, NASA Jet Propulsion Labs, Space Shuttle Orbiter Training Facility, Physiological Training Center and the Weightless Training Facility.
July 14-17
1990 ASERA Meeting
Location: Freeway Hotel and Curtin University of Technology, Perth, Western Australia
Contact: Dr David Treagust, SMEC, Curtin University of Technology, Bentley, WA 6102, Australia
Science educators interested in science education research are invited to attend the annual meeting of the Australian Science Education Research Association, an ICASE member association. For those attending CONASTA, there will be a direct flight from Alice Springs to Perth on the 14th July. A subsidy is available for those presenting their first ever paper.

August 19-24
Third International Conference on Teaching Statistics
Location: University of Otago, Dunedin, New Zealand
Contact: The Secretary, ICOTS 3 Local Organising Committee, Department of Mathematics & Statistics, University of Otago, PO Box 56, Dunedin, New Zealand
ICOTS 3 aims to improve the quality of statistics instruction on a world-wide basis, fostering international cooperation among teachers of statistics, and promoting the interchange of ideas about teaching materials, methods and content. The program includes plenary, invited and contributed paper sessions, workshops, panel and poster sessions. Teaching from beginning school to college, polytechnic and university level will be included, as well as sessions on teaching statistics in government, business and industry. Opportunities will be provided to see and experiment with the latest computer hardware and software.

August 20-24
British Association for the Advancement of Science Annual Meeting
Location: Swansea, UK
Contact: Dr Connie Martin, British Association for the Advancement of Science, Fortress House, 23 Savile Row, London W1X 1AB, UK
The theme of the 1990 Annual Meeting will be "The Environment" which will be addressed through a program of lectures, debates, demonstrations, exhibitions and a young people's program. There will also be an education program on the theme International Perspectives of Education, which will include sessions on the development of education in Commonwealth countries, in European countries, and in environmental education.

August 26-31
SCICON 1990
Location: University of Canterbury, Christchurch, New Zealand
Contact: Conference Secretary, SCICON 1990, Department of Continuing Education, University of Canterbury, Christchurch, New Zealand
SCICON 1990 will be the seventh biennial conference of the New Zealand Science Teachers Association. Workshops, laboratory sessions, seminars, discussion groups, access sessions, and keynote addresses will address the theme Science for tomorrow's world. The program also includes field trips and visits to research institutes, industries and places of scientific interest.

August 27-30
ASET-ICASE Conference on Science & Technology for Developing Countries
Location: Port of Spain, Trinidad, West Indies
Contact: Conference 90, ASETT, Faculty of Education, University of the West Indies, St Augustine, Trinidad & Tobago, WI
The Association for Science Education of Trinidad and Tobago (ASET) in collaboration with ICASE will host a conference on "Education in Science and Technology for Development: Perspectives for the 21st Century". The conference will be open to science and technology educators of all countries, but Caribbean problems will be of particular interest. The conference aims to provide a varied program focusing on (1) scientific and technological developments as they impact upon our lives at present, and are likely to impact upon our lives in the 21st century; (2) social and ethical issues consequential on developments in science and technology; (3) the thrust of modern technology and the implications for science and technology education; (4) educational technology and the teaching of science - developments in resource materials production for the teaching of science and technology; (5) appraising present curriculum trends in science and technology education in the Caribbean and Latin American subregions and worldwide; (6) the schools and universities/industry interface; (7) bridging the gap in science education - primary through tertiary; and (8) action towards the goal of science and technology education for all with appropriate emphases on the popularisation of science, science clubs and out of school science activities.

August 31 - September 2
CTC-IUPAC Meeting: International Symposium on the Environment and Chemistry Teaching
Location: Moscow State University, Moscow, USSR
Contact: Prof Y Tretinkov, Chemistry Department, Moscow State University, Moscow 117234, USSR

September 5-7
ICASE European Symposium on Industry and Education
Location: Brussels, Belgium
Contact: Drs Jan Hendriks, ICASE European Representative, Konijnepad 3, 7921 BM Zuidwolde (DR), Netherlands
Invitations have been sent to member associations of ICASE and to other bodies in Europe, USA, Canada and Australia to nominate education representatives to attend. Industry representatives are being invited by Conseil Europeen des Federations de l'Industrie Chimique (CEFIC). The symposium will (1) provide opportunities for the exchange of information and experiences in schemes for industry-education liaison, (2) develop models for industry-education liaison, (3) establish a network for information exchange for future developments, and (4) publish a resource book for teachers and administrators on industry-education liaison.
September 10-20  
Seminar on STS Education  
Location: University of Oxford, Oxford, UK  
Contact: The Director, Courses Department, The British Council, 65 Davies Street, London W1Y 2AA, UK  
The British Council announces its forthcoming seminar on "Science Technology and Society Education: Developing a Relevant Science Education for the Future". This seminar has vacancies for 40 participants and is intended for experienced science teachers, senior educators with responsibility for science curriculum development, school science inspectors and advisers, and teacher trainers. The seminar will consider a wide range of educational issues which arise when science and technology are taught in the context of their social interactions. The following topics will be considered - rationale for STS, developing new curriculum materials in schools, innovations in teaching STS, research into STS in the classroom, studying the environment, ethical and gender considerations, monitoring changes in new technology, media influence on our students' ideas, and the way forward.

October 18-20  
World Environment Energy and Economic Conference  
Location: Winnipeg Convention Centre & Holiday Inn, Winnipeg, Canada  
Contact: Mr Jack Pyra, Past President STAM, John W Gunn School, Winnipeg, MB R2C 3C9, Canada; or Mr Bob Lepischak, President ICASE, Neepawa Area Collegiate, Neepawa, MB, Canada R0J 1H0  
This conference, endorsed by ICASE and the Canadian Association for Science Education, and hosted by the Science Teachers Association of Manitoba, will focus on the theme "Sustainable Development Strategies - The New World Agenda". A program is being prepared to interest educators, youth and the general public. Businesses and industries are being invited to participate. The conference will enable participants to examine and discuss the links that must be fashioned so as to integrate environmental concerns with continued development on the energy, resource and economic fronts. The program will address the role that curriculum, teachers and schools can play in helping students understand the environmental realities which are the cornerstone of sustainable development.  
An International Symposium on Sustainable Development will precede the conference on October 15-17. International representatives from education, government and industry will meet to examine the implication of sustainable development upon the curriculum and students of tomorrow.

November 7-11  
NABT Annual Meeting  
Location: Westin Galleria & Westin Oaks Hotels, Houston, Texas, USA  
Contact: National Association of Biology Teachers, 11250 Roger Bacon Drive, Reston, Virginia 22090, USA  
The theme of this conference is Planet Earth in Crisis. International delegates are welcome. A feature of this year's program will be contributions by international participants and an international reception.

December 12-14  
ASPEN Meeting on Demonstration Experiments and Computer-Aided Learning in Physics  
Location: Pune, India  
Contact: Prof Arun Nigavekar, Physics Department, Poona University, Pune, India  

December 27 - January 1  
International Conference on Teaching of Physics  
Location: Karachi, Pakistan  
Contact: Mrs Aziz F Hasnain, Head, Department of Physics, APWA Government College for Women, F 'B' Area, Karachi, Pakistan  
The theme of this international event is The changing face of physics education in developing countries. The conference aims to discuss techniques for conceptual teaching in physics, to create awareness among physics teachers about modern teaching methods including the use of computers and audiovisual aids, and to establish a research program in physics education.

1991

January 4-7  
ASE Annual Meeting  
Location: University of Birmingham, Birmingham, UK  
Contact: Annual Meeting Secretary, ASE Headquarters, College Lane, Hatfield AL10 9AA, UK  
Full details of this large international event will be circulated with the September issue of Education in Science, the journal of the Association for Science Education. A special feature of this meeting will be an ICASE Symposium. Non-members of ASE and those outside the UK who wish to receive details should write to the contact above.

March 27-30  
NSTA National Convention  
Location: Houston, Texas, USA  
Contact: Linda Crow, Asst Professor, Baylor College of Medicine, One Baylor Plaza, Room 633E, Houston, Texas 77030, USA

March 29 - April 3  
7th ICASE-Asian Symposium  
Location: East China Normal University, Shanghai, China  
Contact: Prof Mi Zihong, Department of Physics, East China Normal University, Shanghai 200062, China  
The ICASE Executive Committee have accepted a proposal from the East China Normal University in conjunction with the Shanghai Association for Science and Technology and the Shanghai Board of Education to host an ICASE Conference. The symposium will be conducted in English/Mandarin and will address the theme Making science education in schools more relevant. The program will focus on (1) the development of appropriate curricula, the issue of integrated science vs separate sciences, the introduction of STS in science courses; (2) innovations in teaching, the role of project work, the teaching of science communication.
skills, low cost equipment, fieldwork; (3) technology in education, the effective use of visual aids, visits to industry, the place of the computer; and (4) research in science education, children's learning in science, assessment techniques. The program will consist of presentations by internationally renown science educators; papers, workshop and discussion sessions; poster displays; and an exhibition. Write to the above address for the second circular. Titles and abstracts of contributed papers should be sent to Prof Mi Zihong by 31 October 1990.

July
GASAT 6 International Conference
Location: University of Melbourne, Victoria, Australia
Contact: Ms Gaell Hildebrand, School of Education,
University of Melbourne, Parkville, Victoria 3052, Australia
In order to be placed on the mailing list for calls for papers, etc, write to Gaell Hildebrand at the address above.

August 4-9
ChemEd 91 Conference
Location: Oshkosh, Wisconsin, USA
Contact: Bruce G Smith, Co-Director, Appleton High
School-West, Appleton, Wisconsin 54914, USA or Paul
Keller, University of Wisconsin, Oshkosh, Wisconsin
54901, USA
ChemEd 91 is a major chemical education conference of
interest to university, college, secondary and elementary
educators from North America and beyond. Throughout the
weeklong conference, activities are planned for all members
of the family including excursions, field trips, sports
activities and social events - a feature of ChemEd
conferences.

August 25-30
11th International Conference on Chemical
Education
Location: University of York, York, UK
Contact: Dr John F Gibson, ICCE 11, Royal Society of
Chemistry, Burlington House, Piccadilly,
London W1V OBN, UK
This biennial conference on the theme Bringing Chemistry
to Life is being organised by the IUPAC Committee on
Teaching of Chemistry in conjunction with UNESCO and
the Association for Science Education. The conference will
focus on (1) making chemistry accessible to all students (2)
new curricula at primary, secondary and post-secondary levels
(3) new teaching strategies at all levels (4) teaching and
learning at a distance (5) new frontiers of chemistry and their
impact on teaching, and (6) research in chemical education.
The program will include plenary lectures, poster papers,
symposia, workshops, exhibitions, times for participants to
discuss aspects of chemical education of special interest,
social events and local visits. A first circular detailing the
broad program and how to contribute is available now. The
second circular will be published in October 1990.

August 26-30
Fourth Asian Chemical Congress
Location: Beijing, China
Contact: Prof Dehe Zhang, Secretary General of 4ACC,
Chinese Chemical Society, PO Box 2709, Beijing 100080,
China
The 4th Asian Chemical Congress will be held under the
sponsorship of the Federation of Asian Chemical Societies.
The Congress will focus on the important role of chemistry
in raising the health conditions and living standards for all
people. The program of plenary lectures, invited papers and
contributed papers will be conducted in English and will
concern various topics including organic chemistry of natural
products, analytical chemistry and instrumentation,
environmental chemistry, agrochemistry, coordination
chemistry and its applications in medicine and agriculture,
polymer science, photochemistry, computers in chemistry,
catalysis, and chemical education.

August 27 - September 1
5th International Environmental Education
Conference
Location: Cusco, Peru
Contact: MSc Eduardo Gil Mora, National University of
Cusco, Zaguanc del Cielo L-9, Cusco, Peru
The conference will focus on the relationship between the
environment and development, and on the changes needed in
today's behaviour for tomorrow's world. The program will
enable participants to learn of developments, approaches and
strategies in environmental education in different countries,
and will cater for primary, secondary and tertiary educators;
and for teacher trainers, curriculum developers, and
policymakers.

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Contact: Dr Jack Holbrook, ICASE Executive Secretary
Department of Curriculum Studies, University of Hong Kong, Hong Kong
or your local association
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President, ICASE  
Neepawa Area Collegiate  
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Canada ROJ 1HO

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Editor, ICASE Journal  
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Monash ACT 2904  
Australia
Science Education International is the Quarterly Journal of the International Council of Associations for Science Education. ICASE was established in 1973 to extend and improve education in science for all children and youth by assisting member associations throughout the world.

This journal provides a means for associations, institutions, centres, foundations, companies and individuals concerned with science education, to share perspectives, concerns, ideas and information which will foster cooperative efforts to improve science education, and which will serve as a chronicle of the advancement of science education throughout the world.

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Q Reissman & M Rollnick
Hands-On Activities from TOPS R Marson

Science Education Around the World
Research for Teaching and Learning
Enhancing Student Creativity John E Penick

Science Teacher Education
In-service Teacher Education for Nigeria's National Primary
Science & Mathematics Project Duro Ajeyalemi

Primary Science

Science Technology Society

Resources

Calendar

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ICASE in East Europe

by Dennis Chisman
Honorary Treasurer, ICASE

ICASE is pleased to welcome the first Institutional Member from East Europe - the University College of Education, Erfurt, German Democratic Republic.

This institution is a teacher training college, with a number of institutes for the training of different subject specialist teachers for schools - including technology, craft and science subjects.

The college is planning a major pan-European symposium on technology education for schools in 1992. ICASE is supporting this meeting. Watch for further details in future issues of Science Education International.

The contact person for the University College of Education is:
Prof Dr Dietrich Blandow
Vice Rector
Pädagogische Hochschule 'Dr Theodore Neubauer'
Nordhauser Strasse 63
Erfurt 5064
DDR

New member of ICASE

The Education Division of the Royal Society of Chemistry has become a member of ICASE. The Division has 4000 members, including about 1000 school teacher members.

The Royal Society of Chemistry is one of the oldest chemical societies in the world - it celebrates its 150th anniversary in 1991. It has more than 40,000 members, of whom about one fifth are outside the United Kingdom.

The Education Division is one of several divisions of the Society serving specialist interests. The Education Division itself has subgroups concerned with curriculum, assessment, educational techniques, chemical education research, and tertiary education.

One of the major international activities with which the Division is concerned at present is the organisation of the Eleventh International Conference on Chemical Education to be held in York, UK from 20-26 August 1991. Refer to the Calendar section in this issue.

Mr Dennis Chisman, the Honorary Treasurer of ICASE, is the President of the RSC Education Division.

The contact for the Royal Society of Chemistry Education Division is:
Dr A D Ashmore
Education Officer
The Royal Society of Chemistry
Burlington House
Picadilly W1A 2BN, UK

Who's Who in Science Education Around the World

A new ICASE initiative is to publish a Who's Who in Science Education Around the World 1991 Edition. This valuable reference book will contain profiles on prominent science educators and their work.

The information will help you to contact colleagues in both developing and developed countries who may be working on projects of interest to you, who may be potential speakers at your next meeting, or who may be invited to work on collaborative projects.

Copies will be sent to all ICASE member associations, institutions, centres, foundations and companies. Copies will also be available to individuals and other organisations at an affordable price. Your help in recommending individuals worthy of inclusion in this biographical volume will be much appreciated. Please send names and full addresses of those you would like to nominate to:

The Editor
Who's Who in Science Education
10 Hawken Street, Monash ACT 2904 Australia

Photo: ICASE Australasian-Pacific Representative, Mr Maris Silis, shows Ms Ampy Ventura the new ICASE Journal in front of the ICASE Display at CONASTA 39, the annual conference of the Australian Science Teachers Association held in Alice Springs in central Australia. Ampy, an Education Program Specialist from the Philippines, is in Australia participating in a training program for physics educators.
ICASE takes active role in NSTA Convention

by Dr Kenneth Russell Roy
North American Representative

ICASE President Bob Lepischak, Honorary Treasurer Dennis Chisman, North American Representative Kenneth Russell Roy, and Special Projects Officer John Penick took an active role at the 1990 NSTA National Convention in Atlanta, Georgia. The Convention entertained approximately 16,000 science educators and leaders from North America. A large number of international representatives also attended.

ICASE hosted an International Breakfast which was attended by representatives from several continents. Each had a chance to share information before the group.

The NSTA International Committee heard presentations by Bob Lepischak and Ken Roy on the activities and future endeavours of ICASE. ICASE representatives took part in the meeting for the purpose of discussing relevant issues and plans of action. In addition, ASE General Secretary David Moore took part in the discussions. The committee is chaired by John Penick.

ICASE also hosted a luncheon at the Convention. Representatives from around the world attended and spoke about their activities and initiatives.

A special forum was coordinated by John Penick where participants could learn more about science education from various countries via in-depth discussions with representatives. This was a highly effective activity in that it allowed for individual dialogue on important issues.

In the exhibitor area, ICASE set up a booth with samples of publications and information brochures on various projects, including ICASE-endorsed meetings. Many delegates stopped to chat about ICASE and its activities.

As can be noted, ICASE fostered international education as a people process in Atlanta. Plans are being made to increase the profile of ICASE at the next National Convention in Houston, Texas next year.

ICASE is grateful to NSTA for the assistance given in arranging these accommodation costs, particularly participants from developing countries.

At the recent world conference on Education for All held in Thailand in March 1990, the importance of developing scientific and technological literacy was affirmed. The congress will provide an excellent opportunity for the international community to follow up the outcomes of this meeting; and to focus on new developments in science technology society education, of which scientific and technological literacy is a key issue.

The ICASE Executive is keen to receive ideas for potential themes for symposia, pre-congress projects which would provide data for and input to the program.

World Congress in Scientific and Technological Literacy

ICASE is currently negotiating with other international organisations to hold a major World Congress in Scientific and Technological Literacy in 1993.

It is envisaged that a large international delegation, representing every region of the world, will meet in Paris, the proposed venue, to consider this important theme, so critical to local, national and international development.

It is hoped that substantial funding will be made available to assist delegates with travel and

ICASE associated with student scholarship program

The Max McGraw Foundation and the National Science Supervisors Association are co-sponsoring the 1990-1991 Thomas Edison/Max McGraw Scholarship Program. This scholarship program is open to junior and senior high school students with an interest in science and engineering, and awards 10 scholarships to students who best exemplify the creativity and ingenuity demonstrated by the life and work of Thomas Edison and Max McGraw. Students in grades 7-12 in the USA, Canada or other participating nations are eligible to apply by submitting a proposal on a completed experiment or a projected idea which would have practical application in the fields of science and/or engineering.

Further details are available from:

Dr Kenneth R Roy, NSSA
National Director, LISE
Suite 227, Copernicus Hall
Central Connecticut State University
New Britain, Connecticut 06050 USA

Eighth ICASE-Asian Symposium

by Prof V K Samaranayake
Chairman SLASME

The Sri Lanka Association for Science and Mathematics Education (SLASME) has accepted an invitation from ICASE to host the Eighth ICASE-Asian Symposium in Sri Lanka, 2-7 August 1992.

An Organising Committee has prepared a draft program, and preliminary planning is well underway. For further enquiries, write to:

Mr Asoka Weerasinghe
Trinity College
Kandy
Sri Lanka
Free Circulation of Scientists
An ICSU Statement

ICASE is an affiliate to ICSU, through its close association with ICSU-CTS, the Committee on Teaching of Science. As such, this ICSU Statement applies to ICASE and its activities. In a world where so much activity is determined on the basis of political alliances and boundaries, it is important to reflect on the principles outlined in this statement.

The International Council of Scientific Unions (ICSU) is the oldest existing non-governmental body committed to international scientific cooperation for the benefit of humanity.

Created in 1931, after its predecessor, the International Research Council, was dissolved because of discrimination against scientists of certain countries, ICSU has been vigorously pursuing a policy of non-discrimination ever since. ICSU maintains that discrimination hinders the free communication and exchange of ideas and information among scientists and thereby blocks the progress of science, which depends on their collective efforts.

ICSU’s Members are 20 International Scientific Unions and 76 national academies of science or research councils. Together these set up international mechanisms to carry out scientific programs of an interdisciplinary nature.

An important factor in the success of these activities, which are concerned with issues such as the protection of the environment, Antarctic regions or space research, is that they are carried out under the aegis of a respected independent and international scientific body such as ICSU. Each Member adheres to the Council’s Statutes when involved in activities carried out within ICSU’s framework. One of the basic principles in these Statutes is that of non-discrimination, which affirms the right and freedom of scientists to associate in international scientific activity without regard to such factors as citizenship, religion, creed, political stance, ethnic origin, race, colour, language, age or sex. All of these rights are embodied in a variety of articles in the International Bill of Human Rights. ICSU seeks to protect, and promote awareness of, the rights and fundamental freedoms of scientists in their scientific pursuits.

ICSU has a well established non-political tradition which is central to its character and operations and it does not permit any of its activities to be disturbed by statements or actions of a political nature.

As the intrinsic nature of science is universal, its success depends on co-operation, interaction and exchange, much of which goes beyond national boundaries. In order to achieve its objectives, scientists involved in ICSU activities must therefore be able to have free access to each other and to scientific data and information. It is only through such access that science can produce its fruits and international scientific co-operation can flourish.

ICSU recognises that scientists are not working in a world where such open access is always assured, and it uses its best endeavours privately to resolve difficulties where they arise. In most cases it has been successful. Where such consultations have failed ICSU has, however, had to publicise acts of discrimination against scientists and take steps to prevent their repetition, even to the extent of encouraging members of the ICSU family to decline invitations to hold meetings in the country concerned. On the basis of its firm and unwavering commitment to the principle of the free circulation of scientists ICSU continues to oppose any tendency to weaken or undermine this principle.

New ICASE Publication
APOLLO 11
A Teacher Resource Book

This new publication, the latest of a series of Commemorative Issues produced by ICASE, has been compiled to commemorate the 20th anniversary of the Apollo 11 Moon Landing 1969-1989. The book, compiled and edited by Linda Crow and Donna Hare, provides information and activities for both elementary and secondary science students.

Send US$10.00 or £6.00 plus 25% postage to:
Dr Jack Holbrook, ICASE Executive Secretary
Department of Curriculum Studies, University of Hong Kong, Hong Kong
Cheques payable to “ICASE”
The Use of Role Play with School Students in Swaziland
A Case Study

by Quinton Reissman and Marissa Rollnick

Introduction
Interest has been generated in the developed world in science teaching which starts from the pupils' experience and actively involves them in the learning process. Curricula such as the Salters Chemistry Course (University of York, 1987) have been developed for GCSE. Further courses are being developed in this line for Balanced Science, and A Level Chemistry. Although it is too early to assess the long term effects of the Salters courses, initial impressions are that it generates enthusiasm and interest in both teachers and pupils.

In the developing world, on the other hand, much of education is at the stage of formalism as defined by Beeby (1966) and teaching tends to be traditional and examination oriented. One important reason for this is the importance of paper qualifications in obtaining employment. It has been asserted that the only way to change teaching styles is to change the type of examination at the end of the course. It is also true to say that the only way to convince teachers to use a new piece of curriculum material is to show them that 'it is in the syllabus'. A further problem for teachers is lack of resources and large class sizes, frequently over 40 students.

This article describes the development and trial of a role play exercise in Swaziland, a small country in southern Africa. This role play is based on the production of ethene and was named The Ethene Role Play.

The ethene role play
The ethene role play is a revision exercise in organic chemistry, aimed at students in Swaziland preparing for O levels, examined by the Cambridge Examination Syndicate. It is a group discussion exercise with the class divided into groups of about eight students. In a class of 40 students, this would mean five groups.

The play takes the form of a discussion between top officials from government, industries and other interested parties, and is chaired by a project evaluator from Tibiyo takaNgwane, a parastatal investment agency with access to both local and international funds. It is a body well known to the public in Swaziland.

Motivation for the project
The role play is an aid to teacher educators, to show that role plays in science at high school are both feasible and useful to inspire student and practising teachers to undertake such exercises. It is for this reason that the teachers' guide includes a detailed listing of the aims and objectives which the role play helps to fulfill. They are quoted directly from the handbook of one of the commonly used syllabi - the Cambridge GCE. As mentioned, most of the science taught in Swaziland is very syllabus oriented, and concentrates on factual content. It tends to neglect the social, political and economic issues surrounding the application of science in society. One of the main objectives of the role play exercise is to show that this active method, rather than the usual teacher-centred discussion, can meet these broader objectives of the syllabus and in fact does so more effectively than other methods.

The package was designed to help practising teachers to conduct the role play with a minimum of time and effort. Since the idea of this kind of play is foreign to the great majority of teachers, a videotape of the trials was produced, including all the preparatory stages to the final performance of the role play. It was hoped that this would make the procedure clear enough for the role play to be undertaken confidently by any teacher.

Writing the role play
Organic chemistry was chosen as the topic for the role play since fermentation features strongly in the syllabus, and Swaziland is also a sugar producing country, which depends on imported petroleum products. The choice of an ethene producing plant is a little artificial, since local demand is not really enough to warrant an ethanol cracker. However it does give much more syllabus coverage than a simple ethanol fermenter and distiller, and reinforces the idea that an organic chemical industry could theoretically be built up through sugar via ethanol and ethene.

An attempt was made to keep the various characters within the realm of the possible, drawing from the biographies of many well known public figures. Similarly the intention was to present as many social, political and economic realities as possible. The following proved to be useful resources:

- The Times of Swaziland, for information about an ethanol fermenter that seems to have been 'in the pipeline' for a number of years now (Times of Swaziland, 1989)
- Facts and Figures for Investors, issued by the SASOL company (Sasol, 1988)
- A personal interview with the chairman of the Swaziland sugar producers association
- The Ethene A Level Package produced by Salters Science Projects (Utley, 1987)
- The booklet Transporting Chemicals which served as a model for the role play (University of York, 1987)

Relationship of the role play to the syllabus
This was a crucial question to address, as teachers are not generally motivated to teach material unrelated to the syllabus.
The ethene role play was designed to help teachers meet certain educational aims and objectives (see opposite) quoted from the 1991 Cambridge combined science and additional combined science syllabus (University of Cambridge Overseas Examination Syndicate, 1988).

**The structure of the role play**

Roles were devised for eight characters to take part in the discussion. The role play has been deliberately designed so that there is no 'right' answer to the discussion. The final decision depends on the character and persuasiveness of the participants.

The bulk of the background information was given to the pupils in the form of a general fact sheet. This sheet contained information about the characters in the role play, uses and production of ethene and some facts and figures related to issues such as plant size, number of jobs, cost, and pollution hazards. They were also given a schematic diagram illustrating the three processes to be discussed in the meeting.

The fact sheet told the pupils that ethene can be made by a number of different processes, each with advantages and disadvantages for Swaziland. A decision as to which type of plant should be built, was to be made by their meeting.

The characters used in the role play were as follows:

- **Mr/Ms Nsibandze**, chairperson and project evaluator from Tibiyo takaNgwane, the parastatal funding organisation
- **Mr/Ms Brown**, representative of the Swaziland Sugar Producer Association proposing an ethanol-based process at Mhluwe, the site of one of Swaziland's sugar mills
- **Mr/Ms du Toit**, representative of the South African Trade Mission, proposing a SASOL type plant near Mpaka, the site of Swaziland's coal mine
- **Mr/Ms Dlamini**, representative of oil companies hoping for a petroleum-based plant at Matsapha, Swaziland's industrial area
- **Chief Busa Hlobhe**, representative of the Swaziland government, pushing for employment and foreign exchange
- **Mr/Ms Leary**, representative from the National Trust Commission, with environmental interests
- **Mr/Ms Mavuso**, representative of the communities in the areas around Mpaka and Mhluwe
- **Mr/Ms Simelane**, representative of the Swaziland Federation of Trade Unions

Each pupil was given a briefing sheet for their role. The role briefing sheets contained thumbnail sketches of the character to be portrayed. For example, the chairman's role is outlined as follows:

*You are in your early forties. After leaving school, you started out as a bank teller and worked your way up to become the manager of a large bank at Nhlangano. This experience gave you the opportunity to get a job at Tibiyo takaNgwane where you have now been promoted to the position of senior project evaluator. You are confident, well experienced with big business and used to keeping people in line. You also know the importance of tact and courtesy when dealing with others in positions of authority, like the delegates at this meeting.*

**Aims**

1. . . . to enable students to acquire sufficient understanding and knowledge to:
   1.1 become confident citizens in a technological world, to take an informed interest in matters of scientific import
   4. stimulate interest and care for the environment
   5. promote an awareness that:
   5.1 the study and practice of science are co-operative and cumulative activities, and are subject to social, economic, technological, ethical and cultural influences and limitations
   5.2 the applications of sciences may be both beneficial and detrimental to the individual, the community and the environment

**Assessment Objectives**

A. Knowledge and understanding

Students should be able to demonstrate knowledge and understanding in relation to:

5. scientific and technological applications with their social, economic and environmental implications

B. Handling information

Students should be able to:

1. locate, select, organise and present information from a variety of sources
2. translate information from one form to another
4. use information to identify patterns, report trends and draw inferences
5. present reasoned explanations for phenomena, patterns and relationships
6. make predictions and hypotheses

**Subject Content**

12. Organic chemistry

12.2 Fuels

- describe petroleum as a mixture of hydrocarbons and its separation into useful fractions by fractional distillation
- name the uses of petroleum fractions

12.5 Alkenes

- describe the manufacture of alkenes and of hydrogen by cracking
- name some uses of poly(ethene) as a typical plastic

12.6 Alcohols

- describe the formation of ethanol by fermentation
- name the uses of ethanol as a solvent; as a fuel; as a constituent of wine and beer
The sheet also provided advice on the part they were to play in the discussion and their interests.

Trialling of the role play

The class chosen for the trial was one preparing to sit for their O level exam (Form 5 in the Swaziland system). It was a co-educational class in a day school, with a mean age of 17 or 18, in an urban setting. The school itself, although not an elite school, is known as one of the better government schools.

This group was perhaps easier to work with than a class in a rural area where the grasp of English is more of a problem. Although English is a second language to almost all students, secondary school instruction, in this case for the past 5 years, is conducted in English. Most students have had their primary school instruction in Siswati, though a handful may have come from English medium primary schools.

In trials it proved useful at the outset to let the class think that they would be having a revision test in organic chemistry. Two double periods were used on different days.

Day 1

On the first day of the exercise, Mr Reissman, the class teacher was assisted by Dr Rollnick, some of her education students and a TV cameraman. Some 40 minutes were spent going through the general fact sheets with the whole class, and dealing with any problems that arose. Then, 15 minutes were spent allocating roles to the various members of the class. Time could have been saved by the teacher doing this unilaterally beforehand, but it was felt that better co-operation would be obtained if individuals were allowed to select their roles as far as possible. The only role where no freedom of choice was allowed was that of chairperson, where it was thought that the teacher's judgment may improve the end result. Although the girls in this particular class tended not to be very assertive, one girl was deliberately made to take the role of chairperson.

For the remainder of the lesson, eight groups were formed, each focusing on one of the characters, and they prepared and discussed problems and strategies relevant to their role. The importance of this stage cannot be underestimated. Most students entered into the spirit of the exercise only after forming into these groups and receiving their role outline. At this stage, the assistant and the teacher all circulated freely among the groups of students, joined in with their discussions, and sorted out a great number of difficulties.

Day 2

The following day, the 39 students in the class were divided into five different "meetings", each located in a different part of the science laboratory. The assistants were again present, but not taking an active part in the proceedings.

The chairpersons commenced the discussions, which were allowed to proceed for 35 minutes. The only intrusions into the discussions were made by the camera crew who tried not to affect the flow of the discussions. Most of the time, the students were so engrossed in their discussions that they did not take much notice of the camera or the microphone.

After 35 minutes, some discussions were beginning to flag, and all groups were asked to wind up within 5 minutes. Each chairperson was called forward one at a time to present the group's conclusions.

Problems encountered in the exercise

As the role play started, many students were still somewhat unsure of themselves, and not quite sure how they ought to start. Such a problem is not easily overcome, but would ease if role plays were used more often in science and in other subjects. Schools with access to a video cassette recorder could show part of the video produced in the trial as part of the introduction to students. The somewhat stilted introduction shown in the video was found to be one way of breaking the ice.

Problems were encountered in obtaining accurate information for the sheet which compared costs for each of the proposed plants. The SASOL corporation volunteered some information, but more with a view to attracting shareholders than to foster a technical grasp of the operation. The Annual Statistical Bulletin issued by the government statistical office was of some help in assessing national requirements of petro-products. Curiously, Tibiyo takNgwane and the sugar companies, which are known to have been involved in feasibility studies for ethanol production, were evasive when approached for information. Hence the data table is one of the weaker items of the package, and needs revision.

During the trial, a team of assistants was available to help solve problems facing particular characters. Teachers, undertaking a role play single handedly for the first time, would no doubt experience some problems.

The video, although revealing, was necessarily of amateur quality since it was made on a domestic VHS camera and edited on two domestic video tape players. Professional
equipment was unavailable.

Other criticisms, mostly from participating students, were:

- Name tags should have been worn by the characters.
- Groups should have been given more privacy. As the discussion became more animated, neighbouring groups tended to distract each other.
- The aim of the exercise was not clear enough.
- Estimated coal reserves for the Mpaka coal mine should have been included in the data table.
- The pollution hazards of each process should have been more accurately stated in the data table.
- The ratio showing capital expenditure vs jobs created should have been included in the data table.
- Roles could have been doubled up in each group of students so that the actors could give each other moral support.
- Why spoil an entertaining exercise by setting a homework followup?

Conclusion: achievements of the role play

Almost all of the class took an active part in the exercise, including those who would not normally contribute - the girls who are often shyer than the boys, and those students who are not known achievers and often afraid to speak out in a teacher-led discussion.

The exercise had great novelty value and stimulated considerable interest from the class.

Most groups became emotionally absorbed in the discussion and came to grips with the issues at stake. In the later stages of discussion, students were generally unaware of the microphone and camera. Science issues were correctly used in arguments, and relational numbers, rather than figures, were often used.

Although English is a second language for most students, they generally succeeded in expressing themselves clearly. The absence of a supervising teacher in the groups encouraged less inhibited discussion. In rural schools where the command of English is generally not as good, teachers would need to decide whether or not to allow discussion to proceed in the vernacular or in mixed language.

The role play was presented to teachers at a workshop in Swaziland, and conducted with the teachers playing the various roles. The teachers were enthusiastic about the exercise, although expressed doubts about conducting it in rural schools where students may not be as forward, or not as aware of current events. This case study has demonstrated that pupils who were normally quiet, were active and involved in this exercise. Once pupils in rural schools appreciated the idea of the exercise, they too should become more vocal.

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About the Authors

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A Matchbox Magnifier

Betty Graham of Santa Fe, New Mexico, USA, sent this idea to the Primary Science Section Editor for a low cost magnifier, following the suggestions in Science Education International Vol 1 No 2 June 1990.

Betty presented this idea at the CESI "Make and Take" at the NSTA National Convention in Atlanta, USA in April of this year.

For more ideas in Primary Science, refer to pages 24 to 26 of this issue.
OBSERVING PENDULUMS

1. Cut a piece of thread as long as your arm.
   Tie a paper clip to one end.

2. Tape it to the bottom edge of your table like this.

3. Pull the paper clip to one side, then let it go. Describe how the paper clip moves.

4. Find a way to make your pendulum swing faster; then slower. Tell how you did this.

5. Hang another pendulum next to your first.

6. Make both pendulums “march together” for at least 10 cycles back and forth. Tell how you did this.

7. Predict how these pendulums will swing. Give reasons for each answer.
LESLIE NOTES
Gather just 7 items to teach all 5 lessons. These
quantities are based on a class size of 30 students
working in pairs:
2 spoons thread.
15 pair scissors
4 rolls tape; masking tape works best
2 boxes paper clips of uniform size and
weight (about 200)
30 coins or washers
1 wall clock with second hand sweep; or
substitute wrist watches
15 rubber bands

Activity 1: Observing Pendulums
4. To lengthen or shorten the pendulum, it's easiest to
simply pull the thread through the tape.
Allow students to discover the relationship be-
tween length and frequency in their own time.
Don't rob them of the joy of discovery by telling them
the "correct" answer before they've had a chance to do
their own experimenting.
5. Fix the second piece of tape even with the first, flush
with the bottom edge of the table. This insures that both
pendulums will hang from the same height.

ANSWERS
3. The paper clip swings back and forth through an arc.
It moves fastest through the bottom of its arc, slows to
a complete stop at the top, then accelerates back down
in the opposite direction. (The paper clip also de-
scribes an ellipse when swung in a circle.)
4. To make a pendulum swing faster, decrease its length;
to slow a pendulum, increase its length.
6. Adjust each pendulum to the same length.
7. Pendulum A swings fastest; C swings slowest; B
and D swing with the same frequency.

Activity 2: Clock Pendulums
1. Note who stood closest to the mark, but don't
declare the winner until everyone is standing.
3. An accurate pendulum clock measures 24.6 cm
from the middle of the paper clip to the pivot point.
Students who adjust their pendulum clocks near
this length, will stand in choir-like unison after 1 minute.

ANSWERS
4. Yes. I estimated much closer to the 60 second mark
when using the pendulum clock. So did the rest of
the class because we all stood up nearly together.

Activity 3: Heavier or Longer?
Write these pendulum terms on your blackboard.

<table>
<thead>
<tr>
<th>CYCLE</th>
<th>FREQUENCY</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="" alt="Diagram of pendulum swing" /></td>
<td><img src="" alt="Diagram of frequency" /></td>
</tr>
</tbody>
</table>

A cycle is two swings, once back and once forth.
The frequency of a pendulum is the number of cycles
it makes in a minute.

Illustrate these terms by making a paper clip
pendulum, counting cycles over a one minute interval
and expressing the resulting frequency in cycles/minute.

ANSWERS
Student answers may differ from these, depending on
the final length of the pendulums they measure:
3. 80 cm. 4. 80 cm. 5. 54 cm.
6. To reduce frequency, make the pendulum longer.
When 10 clips were hung in a long chain, the fre-
quency dropped from 80 cm to 54 cm. It was in-
creased length, not weight, that made this difference.
When the 10 clips were added in a bunch, the fre-
quency remained unchanged at 80 cm, despite the added
weight.

Activity 4: Little Swings / Big Swings
4. At large amplitudes, the pendulum may swing a
cycle or two slower than at medium or very small
amplitudes. This is a real difference brought on by
jerky, uneven motion in the bob. Random experimen-
tal error may also scatter the values to some extent.

ANSWERS
4. Student values may differ from these, depending on
the exact length of the pendulums they measure:
4a. Frequency for LARGE amplitude = 48 cm.
4b. Frequency for MEDIUM amplitude = 49 cm.
4c. Frequency for SMALL amplitude = 49 cm.
5. The amplitude has little effect on pendulum fre-
quency. Pendulums moving through large, medium
and small amplitudes all had frequency values that
remained relatively unchanged at 48 or 49 cycles per
minute.
6a. Shorten a pendulum to increase frequency.
Lengthen a pendulum to decrease frequency.
6b. Bob weight has no effect on frequency.
6c. Amplitude has little effect on frequency. (Large
amplitudes may reduce the frequency slightly.)

Activity 5: Energy Transfer
Think about pushing someone in a swing. You
can only push at the height of the backswing, when
the person just stops and begins moving forward. This
swing, like all pendulums, only accepts energy when
delivered in phase with its own natural frequency.
Demonstrate this principle with a long and short
pendulum. Notice how you must push the long pendu-
ulum slowly to keep it going, but the short pendulum
rapidly, each in time with its own natural frequency.
If this energy is not delivered in phase, it won't keep
going. Illustrate by pushing the long pendulum too
rapidly and the short pendulum too slowly.

ANSWERS
3. The pendulums shift their energy of motion from one
to the other. As one slows to a stop, the other reaches
maximum energy. Then the process reverses.
4. A high rubber band transfers the energy between
pendulums rather slowly. As you move it down, these
energy transfers become more rapid.
5. No. When you set one pendulum in motion, it will not
be able to transfer much energy to the other. Because
it has a different frequency (different length), it swings
cut of phase with the other.
6. The pendulum you swing first transfers only part of
its energy before gaining it back again. It slows down
and speeds up while the other, originally at rest, starts
and stops.
CLOCK PENDULUMS

1. Stand up when you think exactly one minute has passed. Your teacher will keep time to see who comes closest.

   Put all watches out of sight... ...get ready, get set, GO!

2. Now make a pendulum clock that ticks exactly 60 seconds in a minute.

   a. Tie an arm-length thread to a paper clip.
   b. Lightly fold a small piece of masking tape over the middle of the thread.
   c. Slide the thread through the tape until you find a length where your pendulum swings exactly one cycle each second.

   PULL THROUGH

   1 second, 2 seconds, 3 seconds, ... 60 seconds

3. Repeat the class experiment in step 1. This time use your pendulum clock to keep time.

   Hide your watches! Ready, set, GO!

4. Did your pendulum clock help you guess one minute more accurately? Explain.
HEAVIER OR LONGER?

1. Cut some thread as long as this paper. Tape it to the edge of your desk so it forms a loop.

2. Hang a paper clip from this loop to make a pendulum.

3. Count how many cycles your pendulum makes in one minute. Frequency?

4. Now make your pendulum heavier. Hang 10 paper clips from the loop. 10 CLIPS THROUGH THE LOOP!

5. Now make your pendulum longer. Arrange the 10 clips to form a chain. ONE LONG CHAIN!

6. To slow a pendulum (make it swing with less frequency) should you make it heavier or longer? Use numbers to support your answer.

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LITTLE SWINGS / BIG SWINGS

1. Make a paper clip pendulum so it hangs about halfway to the floor.

2. Pull out the arm of the paper clip to make a hook.

3. Add about 10 clips to the hook to make a heavy pendulum bob.

4. Amplitude is the amount of swing. Find the frequency (in cycles per minute) for these 3 amplitudes.
   - a. Frequency for large amplitude.
   - b. Frequency for medium amplitude.
   - c. Frequency for very small amplitude.

5. When you change the amplitude, does the frequency change by much? Include frequency values in your answer.

6. Tell how each variable changes the frequency of a pendulum (if at all).
   - a. LENGTH
   - b. BOB WEIGHT
   - c. AMPLITUDE

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ENERGY TRANSFER

1. Tape 2 coins to pieces of thread. Hang them from your table like this:

   Twice as long as this paper.

2. Loop each pendulum over a rubber band so it rests about halfway up.

   Loop each side.

3. While 1 coin hangs still, pull back the other and let it swing.

   Do the swinging coins transfer energy? Explain how you know.

4. What happens as you move the rubber band up or down?

5. Predict: Can one pendulum transfer all its energy to the other if they have different lengths? Explain your reasoning.

   REMEMBER: Each pendulum swings at a different frequency.

6. Test your prediction. How do the pendulums interact?
Consultation Meeting on Information Exchange in STME

by Lucille C Gregorio

At the Institute for Science and Mathematics Education Development, University of the Philippines, UNESCO-INISTE, the Information Network for Science and Technology Education organised a consultation meeting on *Information Exchange in Science Technology and Mathematics Education*. This was held on 18-20 April 1990.

The meeting was attended by participants who were science educators and information specialists from Bahrain, Jordan, Republic of Korea, Malaysia, Nepal, Philippines and Thailand. UNESCO Paris was represented by Ms Maria Malevri, Assistant Program Specialist in Information Exchange; while ICASE and ICSU-CTS were represented by Mr Dennis Chisman, the Honorary Treasurer of ICASE. Co-ordinating the meeting was Mrs Lucille C Gregorio, President Elect of ICASE.

The objectives of the meeting were:
- to discuss suggestions for possible future cooperation among INISTE members
- to explore further the fields of science, technology and mathematics education that are of current priority and particular interest to the member institutions
- to suggest appropriate ways of gathering and retrieving information as well as the creation and extension of databases.

During the sharing of country experiences, the participants reported on (1) the infrastructure on information exchange existing in each country; (2) the type of information needed to be exchanged and how; (3) the information stored in existing databases; (4) the hardware and software currently used; (5) how individual teachers gain access to the system; and (6) the applications and uses of the data system.

The meeting proposed projects for improving information exchange in science technology and mathematics education at the national and regional levels, which will lead to greater cooperation among countries and enhance the quality of STME at all levels in the participating countries. The areas in STME which were selected as priorities for collaboration are:
- science technology and mathematics curricula
- teacher education
- teaching aids
- research and evaluation
- policy making and planning
- publications and journals
- high level manpower (consultants)
- teaching methods

The participants agreed that a pilot project should be considered in order to be able to exchange computerised information on STME, and that INISTE should expand and explore other ways of collaborating with other agencies, for example UNDP, ADB and others.

European Youth Science Network

EURYSN, the European Youth Science Network, is a new international framework for young people and organisations involved in youth science, the sciences and youth affairs.

The Network aims to encourage and promote Youth Science in Europe by:
- providing a forum within Europe for organisations and individuals dealing in the area of youth science.
- providing a framework within which common activities can take place.
- encouraging more youth organisations in Europe to have a science element to the personal and social development of young people through "Science in Society".

Activities include information exchange, meetings and receiving *Copernicus*, the EURYSN Journal.

The organisations and individuals from the following countries are currently participating in EURYSN - Belgium, Czechoslovakia, France, Greece, Ireland, Italy, Malta, Netherlands, Norway, Portugal, Spain, Sweden, United Kingdom, and Yugoslavia.

For further information, contact:

EURYSN

c/o IAYSG

37 North Great Georges Street
Dublin 1, Ireland
The principal goals of the Committee on Teaching of Science are:
• to develop and enhance, on an international scale, the teaching of science at all levels of education and training
• to cooperate with other organisations to further all aspects of the teaching of science
• to facilitate cooperation between the Teaching Commissions of the International Scientific Unions.

Seventeen scientific union members of ICUS have representation on and participate in the activities of CTS. COSTED and ICASE are affiliate organisations.

Scientific meetings
Representatives of CTS were participants and observers at a number of conferences sponsored by scientific unions. The Teaching Commissions of IUPAP, IUPAC, IGU, and the Secretary of CTS participated in the Workshop on Energy and the Environment as related to Chemistry Teaching, co-sponsored by Unesco, USDOE and IUPAC/CTC.

Education and training activities
The major workshop activity of CTS was the planning of the Zimbabwe Workshop on the Preparation of Innovative Teaching Materials for Science Education. The workshop, scheduled for January 1991, will include participants with responsibility for science education from a number of African countries. The workshop is being co-sponsored by The African Biosciences Network, Unesco, FASE, The British Council, and the Commonwealth Foundation.

CTS is co-sponsoring the ICUS-Unesco Project in University Science Teaching. The Project is developing science curricula in biology, chemistry and physics at university centres in Thailand. It is planned that the newly developed programs will provide prototypes for post-secondary educational institutions in other developing countries.

CTS and ICMI are collaborating on the Science and Mathematics Education of Future Elementary Teachers Project, sponsored by Unesco and ICMI.

Activities involving developing countries
The low-cost, locally-produced scientific equipment project by CTS focuses almost exclusively upon science education in the developing world. The project is developing specifications for the production of laboratory equipment and the training of science educators in the production of the equipment. Collaboration between CTS, WHO and IUB is being considered as a means to expand this project.

The CTS projects are concerned with and address problems associated with the production of scientifically sound, low cost materials for teachers and trainers of teachers in the developing world. CTS projects currently underway address the important elements of disseminating scientific information and methodology to the broadest range of constituents.

Publications
Several publications have been in preparation during the past year. The first is a handbook devoted to information processing, microprocessors and computers in science teaching, and is being prepared by a subcommittee of CTS. It will be made available free to science teachers and students worldwide.

Plans are underway to produce a volume that includes selected papers from the 1985 ICUS-CTS Bangalore Conference on "Science and Technology Education and Future Human Needs". The papers of the Conference were initially published as nine volumes. It is deemed important by CTS to extract the papers that meet particularly critical needs in science education and republish them in a single volume for greater access by science educators.

Special projects
The Education in Global Change Project is in its first phase of curriculum materials development. The Project will design and produce classroom materials for secondary science students that incorporate the most recent scientific data pertinent to global change research. Science educators and global change scientists are participating in the production and review of teaching units. The materials development team met in June 1990 to design and draft the initial four instructional units for classroom trials. Upon the successful completion of the first phase of the project, a second phase will occur in 1991. It is planned to initiate teacher training workshops in various parts of the world in 1992 as the second phase of materials development is underway.

Plans are being made for a workshop on teaching about ethical problems in science with the intention to reach a diverse, international audience. The team planning the workshop is made up of scientists and science educators who have a commitment to teaching about ethical issues in science. Pending the availability of funding, the workshop is tentatively scheduled for late in 1990.

New areas of interest
There are three areas that CTS is examining for possible future activities. The first is in conjunction with the ICUS-UNDP project entitled Strengthening Science Training and Research in the Third World. The CTS component of the project would involve the development of prototype teaching units for teaching interdisciplinary science at the tertiary level of education. The second is the preparation of instructional materials and sponsoring of teacher workshops addressing the scientific aspects of natural disasters. The third is the concern with the public understanding of scientific concepts. These projects, presently concept papers, if pursued, will take form over the next year.
SATIS 8-13
Placing science & technology in context for 8-13 year olds
by John Stringer, Project Director

The Early SATIS Project is moving from a phase where needs were explored, and structures established, into a time of active writing and materials development.

In response to teacher requests, SATIS 8-13 will chiefly comprise of short, stand-alone units, which are grouped thematically as far as possible. Individual units can be used sequentially or simultaneously, allowing a wide range of teaching strategies.

Some of the materials will address the issue of liaison between primary and secondary schools, facilitating good practice in continuity.

Central Television has offered us national, networked time during schools broadcasts to primary schools in 1992 for some specific SATIS programs; BBC School Radio is planning five SATIS programs for younger secondary pupils in the same term.

The first trial materials will be sent to schools shortly; on their reports, and the advice of reviewers, the units will be revised and edited.

There are 28 local groups developing around the country, including Scotland, Wales and Northern Ireland. Many of them will be making contact with industries in their locality. We are looking forward to the publication of an exciting and influential project.

Further information can be obtained from the Early SATIS Project, Barclays Venture Centre, University of Warwick Science Park, Sir William Lyons Road, Coventry CV4 7EZ, UK.

India: Children and Trees Project

The Children and Trees Project is an environmental education project designed to encourage environmental awareness among children.

The project materials consist of teachers' packs that help teachers to understand and teach environmental concepts related to the following books:

A child and a tree - about planting trees, the effects of soil erosion and the importance of maintaining tree cover.

Mala the mongoose - about water control, bunding, trees and land management.

Elephant and dragonfly - about the diminishing forests and the damaging effect on wildlife, especially on the Asian elephant.

The books are suitable for schools and village action programs and are produced using illustrations from the books.

The immediate aim of the project is to provide at least one copy of A child and a tree for each school in the local language of each major region. It is hoped that eventually ten copies of each book will be distributed to every school in India.

Further information is available from:
Project Coordinators
Children and Trees Project
Shanta, Success Road
Auroville
Kottakuppam 605 104
Tamil Nadu
India

Cameroon Association for Science Education: to be or not to be?

by Augustin Kiteh
Government High School

The concern for and focus upon science is not confined to Cameroon, but is common to nations all over the world. The aim is to produce a new generation of citizens, scientifically literate and thus better prepared to function in a world that is increasingly influenced by science and technology.

School science today is socially controlled, being the product of particular sets of choices made by particular groups of people at particular times. In initiating reforms in science education in Cameroon, there is a need for concerted action by all groups such as the Physics Teachers Association, Natural Science Teachers Association, Mathematics Teachers Association, etc. The single key issue which science educators need to address in Cameroon is how a more appropriate set of expectations and structures in science education can be created.

There is an ongoing effort by The British Council to change the face of physics and mathematics education in anglophone Cameroon; it supports innovative programs in physics and mathematics, run very largely by teachers for teachers; and it conceives and designs professional development activities to expand the repertoire of teaching strategies.

The worldwide shift of focus from "Education about Science" and "Education in Science" to "Education through Science" has implications for the science curriculum. Science and technology education has experienced a revolution that has given birth to a variety of associations - both national and international - which are concerned with the improvement of science education in schools and the advancement of science and technology in people's culture.

This is the challenge for the Cameroon Association for Science Education (CASE) if it is to be; but, if it is not, Cameroon may well be down on the league table of educational innovations from a comparative point of view in the third world. How can Cameroon fight the development problems of today and tomorrow with the rusty and irrelevant weapons of yesterday - the methods, educational technologies and strategies designed for a past generation?

When a nation sees itself to be successful in international competition, it tends to regard its education system as one of the foundations of that success. This, in Cameroon, depends on administrative, technical and educational responsibility and the decision of planners, practitioners, researchers and educators.

Augustin Kiteh teaches at Government High School, Nkambe, NW Province, Cameroon.

MNU Conference Outcomes
8-12 April 1990

by Drs Erik Jongejan

The 99th conference of the West German MNU Association was held in Munich, the capital of the federal state of Bavaria. MNU is an association for teachers of mathematics, physics, chemistry, biology and information theory. Among the 2000 participants, 100 were from East Germany. There were also participants from the Soviet Union, France, Luxembourg, Switzerland, Austria, Belgium and the Netherlands.

One of the major speakers was Professor Gerd Binnig, 1986 Winner of the Nobel Prize in Physics. He spoke on the topic "Creativity of nature and man", describing how the order in material and social structures in both inanimate and animate nature, is similar to the order which characterises the world itself.

During the congress, the chairmen of associations of natural science in West Germany, France and the Netherlands met to consider the outcomes and declaration of the 1989 European Congress of Teachers of Biology and Geology (see page 17). The meeting clarified the general picture of biology instruction in the three countries - the level of final examinations, the content of biology instruction for 12-15 year olds and for 15-18 year olds, the amount of practical work included, class sizes, the availability of technical assistance in the laboratory, funding sources, and the amount of curriculum development occurring. In France, primary teacher training will involve a five year training course, three of which will be undertaken at a university, which will result in a financial improvement for primary teachers. Class sizes can be as many as 35, and sometimes up to 42 students, although for practical work the limit is 25 students. In the Netherlands, the maximum class size is 24 pupils for safety reasons. In Germany, the situation is that all states do not yet engage technical assistants in science laboratories. Sometimes the city, rather than the state, funds one assistant per four teachers.

As a result of this meeting, it is proposed to press for a maximum of 18 students in practical classes. Practical work is essential for instruction in biology and natural science. It is hoped that Britain will become involved in the followup talks. In October, the group will meet in Paris to plan a congress in order to produce a joint statement concerning biology education.

It is planned to present such a joint statement to the twelve EEC ministers of education. Members of associations of natural science in EEC countries who endorse such a European wide initiative are encouraged to contact the NVON Chairman:

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Smelnhof 25
NL 6596 DR Milsbeek
The Netherlands
Enhancing Student Creativity
by John E Penick

Creativity is the essence of science. Creative persons learn more and are more observant. It is no surprise that science teachers the world over say that enhancing student creativity is one of their goals. But, creativity does not happen by chance alone. Teachers wishing to teach for creativity must carefully and consistently structure the classroom to maximise opportunities for creative endeavour, paying special attention to time, teacher role, and expectations of and for students.

Teachers must provide students intellectual freedom to be spontaneous, to structure their time to some extent, and to decide on courses of action. Rushing to a judgement or product is the opposite of the creative process. Rather, we must ask questions and provide time for observation, contemplation, response, and reflection. Without this, rather than creativity we will foster conformity and dependence via quick answers and no thought.

The role of the teacher
Providing students with creative time enhances creativity regardless of the role of the teacher. And, teachers demonstrating appropriate classroom behaviours are even more likely to have desired results. Since much of creative thinking centres around observations, questions, and possibilities, too must the teacher’s behaviour.

Students need something to view if they are to make observations and we must teach them how. Typically, students are told to observe, observations are counted and commented on, and the lesson moves on. Instead, if your goal is better observations, you must follow observations with teaching the student strategies to observe more. If students exhaust their supply of simple observations, help them to focus on applications (the candle will burn string, will burn hair, etc), possession (her candle is burning, Megan’s candle is burning, Lucas’ candle is burning, etc), location (the candle burns on the table, on the floor, sideways, etc), or time (the candle is burning now, is burning at 9.07, at 10.00, etc). These are not trivial observations. Each, in a scientific context, could carry considerable meaning. But, students who do think of them may feel that they are not worthy because they are unconventional and few students will think in these terms. Increased creativity, however, allows students to stay from the norm, to take risks, to seek the unusual. The creative individual looks at one thing and sees another. And you, as teacher, must help them know their ideas have value.

The teacher is quite important in such creativity. Well-posed questions stimulate thinking, revealing alternate points of view and logic, and may be viewed as the embodiment of curiosity. But, to be a model of creative inquiry, a teacher must use questions which go beyond mere description. Questions to stimulate creativity must require and allow multiple possible answers and demand action. Questions model our thinking as we pursue a relevant problem. Questions act as windows on the phenomenon in question as we ask a question, select the best answer, and ask the next logical question, continuing the process until the desired evidence or explanation has been revealed.

We should ask questions to obtain information, not to test students. When we seek information, we don't ask questions if we already know the answer. In good adult conversation, adults ask each other questions to find out, not to examine. We wouldn't spend much time with an adult who continually quizzed us. Our students are not different except they are captives in our classroom. As a rule of thumb in the classroom, if you wish to stimulate student involvement and creativity, never ask if you already know. We should also seek opinions and points of view as "How would you design an experiment to...?"

To stimulate multiple answers we must accept all answers, regardless of how good they may be. To encourage students to tell us their thinking, we must show them that each of their ideas has value, that we are paying attention to them. And, since evaluation stifles creative thought and reduces thinking to imitation, we must avoid judgement. But, this doesn't mean we let everything pass by without comment.

Evaluation, rather than arising from the teacher's singular perspective, the norm, or tradition, must be based on causes and consequences. For instance, a student, using a two-pan balance asks "Is this balanced?" The teacher could easily say yes or no, and get on with the activity. But, such a response does...
little to help the student understand or be confident. Think how different is
the scenario where the teacher, instead, replies "What do you mean by
balanced?" The student is now forced into considering the meaning and the
teacher learns more of the student's thought process. In real science,
evaluation always comes from causes and consequences, not from authority
alone. Why should our science classes be any different?

Students may also become dependent on the teacher for the praise associated
with positive evaluation. And, the more dependent students become, the
less likely they are to stray from the conventional and the teacher's certain
praise. All scholars and practitioners who study creative thinking agree that
evaluation must be totally avoided in the early creative stages and, when
evaluation does appear, must arise from individuals as they analyse their
ideas, actions, and products in terms of personal needs, utility, prediction, or
logic.

In the classroom

Teachers can easily make a difference by the structure they provide and the
atmosphere they create. If you wish to see creativity flourish in your

- Provide opportunities for creative
  work (time, materials, expectations)
- Ask questions that demand answers
  (no "yes/no", recall, or answers you
  already know)
- Wait for responses (don't rush, if you
  really ask a question, wait for the
  answer, and wait for and encourage
  multiple responses)
- Accept unusual ideas, questions, or
  products (no judgement, just
  acknowledge and ask for more)
- Ask students to examine causes and
  consequences (if that's true, then . . . ?
  What may have caused that?)
- Allow students to make decisions
  (structure activities so that decisions
  must be made and allow students to do
  so)
- Model creative thinking, action, and
  decision-making (ask questions
  yourself, express curiosity, make your
  room stimulating)

As you model creative behaviour, ask
good questions, wait and expect
multiple responses, and seek
evaluation based on causes and
consequences, you will find you and
your students change. The change will
be in the direction of being more
creative, having more ideas, seeing
more possibilities. We will all be
better for it.

For further reading
creativity as a result of science
instruction What Research Says to the
Science Teacher Vol 4, NSTA,
Washington, DC
Torrance E P (1965) Rewarding
Creative Behaviour Englewood Cliffs,
NJ: Prentice Hall Inc

About the Author
Dr John E Penick is Professor and
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Professor Penick's interests include
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ICASE Projects.

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This award honours individuals who have made a significant contribution to
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at the local and regional levels

ICASE Association Award
This award recognises individuals who, within their science teacher association, have
made a significant contribution to the international activity of their association

Contact Dr Jack Holbrook, Executive Secretary ICASE
Department of Curriculum Studies, University of Hong Kong, Hong Kong
"All you need is imagination, action, and desire", says Evhan Uzwyshyn to one of the 2000 female students seeking career advice at the Women in Science and Non-traditional Careers Conference which he has been organising for the past eight years at the University of Winnipeg. The two day symposium with more than 100 female speakers is designed to destroy common conceptions about women's possible job roles in the twenty-first century, inviting female students to explore and enter the vastly male-dominated field of science and technology.

Since receiving the 1986 International Science Educator of the Year Award, Evhan has been involved in various activities. Evhan was presented with the YSF Distinguished Service Award in recognition for his participation and accomplishment in the development and success of the Manitoba Schools Science Symposium by David Hall, past Executive Director of the Youth Science Foundation. "Science education, properly understood, is the enthusiastic explanation of the free and beautiful catchings of a child" mused Evhan on receiving the award.

The MSSS is one of the most successful and largest science fairs in the world with over 700 projects entered each year, annually sending three students to both the London International Youth Science Fortnight and the Canada Wide Science Fair. In 1988, Evhan was the treasurer for the planning committee of the Canada Wide Science Fair held in Winnipeg. Over 100 regions of Canada were represented and the fair was very successful. Currently on the board of directors of the Youth Science Foundation promoting extracurricular activities for Canadian science students, Evhan also continues to be a treasurer and fundraiser for the Manitoba Schools Science Symposium, having held the position for ten years.

On the board of Meeting Planners International as Education Chairman, Evhan facilitates networking between different professional bodies in the science and business world; he edited a provincial newsletter for 1988, and attended an editors conference in Dallas, Texas. For the past four years, also in Texas, Evhan arranged, with ICASE President Bob Lepishak, the NASA-CASE Space Seminars for Canadian teachers at the Johnson Space Center in Houston, giving teachers a chance to update themselves on the latest aspects of space education and research.

Recently, Evhan attended the first Canadian (sponsored by ICASE, CASE, STAO and APSQ) science congress in Ottawa, organising a session on sustainable development strategies given by the Hon. Harry Enns, Minister of Natural Resources in the province of Manitoba. This sparked the idea for the World Environment Energy and Economic Conference to be held in Winnipeg in October this year. As organising secretary, Evhan is planning a pre-conference on sustainable development curriculum and a post-conference of Science Olympics for youth with teams from around the world. Fifty international science educators have been invited to design models on sustainable development, and international spokesmen such as Robert Bateman and Dr David Suzuki will give talks.

Evhan has recently returned from a conference in Moscow hosted by the Soviet Academy of Science on "Russia in the Twentieth Century". He has organised teacher seminars on the Human Genome Project, DNA Biotechnology and a workshop on Biodiversity. "The language of science is the human imagination" says Evhan, "and therefore, is international. We must strive towards a scientific literacy which is capable of carrying our planet through the twenty-first century."

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Dennis Chisman, Hon Treasurer ICASE, Knapp Hill South Harting, Petersfield GU31 5LR, UK
In-Service Teacher Education for Nigeria's National Primary Science and Mathematics Project

Duro Ajeyalemi

Although rudiments of science were introduced into the school curriculum in Nigeria as far back as 1859, very little of science, in any form - nature study, hygiene, general science or primary science - was taught in most of the primary schools even as late as 1980. The absence of a nationally uniform primary science curriculum in such a centrally controlled educational system before 1980, was indicative of the relative neglect of primary science education by policy-makers. Existing science programs were taught by teachers who were largely incompetent in science, and who emphasised the informational aspects of science, contrary to the inquiry teaching approaches.

Consequently, pupils were mainly trained to remember, but not to understand, think or apply (Yoloye 1983). The teaching of Mathematics at the primary level suffered a similar fate - only arithmetic was taught in most schools and most pupils were bored by the didactic teaching methods employed by most teachers.

The deplorable state of primary science and mathematics education was more than apparent by the late 1970s, and the Federal Government decided to intervene. Core Curricula on Primary Science and Mathematics (Nigeria 1980a,b) were developed and the Nigerian Educational Research Council (NERC) was funded to ensure nation-wide implementation. The core curriculum in each subject was first reviewed and enriched by a team of resource persons selected from universities, teachers' colleges, educational resource centres, and the NERC. A teaching curriculum, based on the report of each review panel, was then developed (NERC 1982). Emphasis was on student activity and direct exploration of the local environment. By 1982, the implementation of the National Primary Science and Mathematics Project (NPSMP) began.

Implementation strategy of NPSMP

It was recognised that nearly all primary school teachers were incompetent to teach science and that the majority had weak backgrounds in mathematics. It was therefore necessary to upgrade the teachers' knowledge of content in both subjects as well as expose them to the philosophy and teaching methodology of each.

As of 1983, 63% of all primary teachers were unqualified to teach any subject, let alone science or mathematics. The problems of implementing the NPSMP were therefore enormous, and caution was necessary. First, it was clear from the costs involved, that sophisticated and largely imported laboratory equipment or other teaching and learning aids could not be provided for all schools. Thus, most of the suggested equipment were low-cost, locally procured, and/or improvisable. This in turn mandated that teacher education for the project needed to emphasise improvisation and exploration of the local environment. Secondly, the two curricula were pilot-tested before nation-wide dissemination, to ensure an evaluation and necessary improvement of the curriculum materials, the equipment and other aids, as well as the suggested teaching and assessment methods. For this purpose, three pilot schools were selected from each of the 300 Local Government Areas (LGAs) in the 19 states of Nigeria existing in 1982 (there are now 449 LGAs and 21 states). Each school nominated at least two teachers for science and for mathematics (six teachers from each LGA and a total of 1800 for each subject). These pilot school teachers needed training, but first, their trainers had to be inducted into the project.

Training programs

Training programs were in three phases: a two-week orientation of teacher-trainers; a four-week training of the pilot school teachers; and similar training of other teachers in all primary schools in each LGA. The model of training was the same in each phase, except that the training personnel changed from one phase to the next. The first phase started at the end of 1982 and was completed by 1987; the second phase took place in 1988; while the last phase is still in progress.

Teacher-trainer's orientation

Teacher-trainers were selected from each state, but were trained on a zone basis (the country was divided into five zones). They were mainly experienced first degree graduate teachers of science and mathematics in secondary schools or teacher-training colleges; some held higher degrees, some were sub-degree certificated teachers, and some were science/mathematics graduate staff of the respective Ministries of Education. Induction into the project was in the form of an intensive two-week
workshops held in each zone. The workshops also served as models to the teacher-trainers, of strategies for pilot school teacher training. The first week involved presentations, group discussions, practical activities and reading/practical assignments directed by resource persons drawn from universities, colleges of education, polytechnics, teacher training colleges, science equipment centres, ministries of education or the NERC.

Presentations and discussions in science or mathematics were held during the morning sessions on such topics as the philosophy and objectives of the project; nature of science, and of mathematics; the curriculum materials and recommended teaching approach (guided discovery); the psychology of learning and the African child, the Nigerian learning environment and resources for teaching science or mathematics; process skill development and concept formation; assessment methods in the cognitive, psychomotor and affective domains; the science or mathematics content difficulty for the primary school teacher; improvisation techniques and development of relevant teaching aids.

Afternoon sessions were devoted to practical activities such as:
- Field trips to different sites - ponds, gardens, markets, local industries, auto mechanic or electrician workshops, etc - for purposes of identifying and locating different resources in the local environment for science and mathematics teaching.
- Development and/or improvisation of teaching aids and equipment using locally available materials.
- Trying out of activities suggested for pupils in the curricula to determine their feasibility, and to evaluate the suitability and effectiveness of equipment (developed by teacher trainers themselves or supplied).

Assignments at the end of the day included familiarisation with the curriculum materials in each subject; planning for lessons to be taught the next week; preparing for field trips; and evaluation of the curricula and teachers guides in terms of perceived difficulty of content for the average primary school teacher and/or pupil, process skills teachable to pupils through the suggested activities and content, and classification of the suggested assessment questions into different thinking levels.

The second week was spent on model and practice teaching by both the course tutors and the teacher trainers, many of whom had never taught in primary schools. The purpose was to familiarise them with the typical primary school classroom, pupils and available facilities, as well as field test the curriculum materials and improvised or supplied equipment. In the first two days, course tutors engaged in model teaching using the curriculum materials, and were each observed by groups of teacher trainers; this was to inspire the teacher trainers and demonstrate the workability of the recommended teaching approach. Each lesson was videotaped and later reviewed in group sessions. The time remaining each day was spent by teacher trainers on earlier assigned topics from the curriculum; each teacher trainer was observed by a group of other teacher trainers and some course tutors. Subsequently, each lesson was played back and critically evaluated in terms of teaching method, particularly on involvement of pupils in practical activities, use of equipment, difficulty of content for pupils vis-a-vis teacher's language, questioning techniques and achievement of lesson objectives as recommended in the curriculum. The review sessions were especially useful for evaluating the strengths and weaknesses of teacher trainers, and were helpful in selecting the final team for pilot school teacher training.

The final day was used for exhibiting equipment and other teaching aids constructed by teacher trainers. This was attended by members of the public, including top government functionaries and teachers in nearby primary schools.

Training of pilot school teachers

This was a four week program, which took place in all states of the country between March and April 1988. The workshops were directed by teams of course tutors and teacher trainers, and the format was essentially the same as that of the orientation of teacher trainers. However, the program included intensive presentations on content earlier identified as difficult for most primary school teachers, and much more time was spent by pilot school teachers on improvisation, development of teaching aids and practical teaching. Samples of equipment ordered from local manufacturers and textbooks developed for pupils under the project were used. Pilot school teachers took away to their school, all equipment and teaching aids developed in the workshop, as well as all curriculum material and teaching guides. Other equipment was supplied directly to each pilot school by the NERC, and pilot school teachers thereafter started implementing the curricula in their schools, with their progress being constantly monitored by NERC field staff, supported by course tutors.

Presently, the training of teachers in other schools of each LGA is in progress. The NPSMP is now widely adopted all over the country, but it is too early to evaluate it summatively. However, it can be reasonably concluded that the inservice program achieved its aims, judging by the commitment and enthusiasm displayed by the majority of pilot teachers.

References


Dr Duro Ajeyalemi is a Fulbright Professor at the Science Education Center, University of Iowa, USA; visiting from the University of Lagos, Nigeria
Where is Science in the Primary School in the Year 1990?

by Alan Cross
Manchester University, UK

This article contains a number of personal reflections based on experience as a teacher of infants and juniors and latterly involved in both in-service and initial training of teachers.

The position of science in primary schools is changing. Politicians and educationalists have sought and increasingly seek to influence that change; however both parents and children are becoming more influential as a generation of teachers learn to accommodate a level of accountability unimagined by some and dreamt of by others.

The position has changed markedly over the last fifteen years and particularly since the Primary Survey of 1978 by Her Majesty's Inspectorate, which found science to be the area "most commonly found to be less well matched to the children's capabilities than work in any other aspect of the curriculum".

At that stage we had a position which had evolved, centred somewhat as it had been for years on the work of major curriculum initiatives like the Schools Council. The HMI report itself stimulated a change in the perception of a significant group in primary education but resulted in little immediate change in practice. Also that year the Department of Education and Science took a significant step publishing Science 5-16 A Statement of Policy. Now we had an official statement saying that science should be part of each child's education.

Discussion at this time was very much about content versus process. The DES document took us a step on from that debate focusing attention on breadth, balance and progression (the statutory orders for the National Curriculum have established a place for both content and process in the curriculum). In the mid eighties, government funds were made available through Educational Support Grants. This money was used by over 90% of LEAs in England and Wales to provide advisory teachers for science (and technology in many cases), recruited largely from the classroom, who focused on support work in school as part of programs of in-service training.

This shift of gear was followed by another in 1988 when the interim report of the National Curriculum Science Working Party was published. What has followed has been a recognition of the importance of science to the stage where primary schools are now implementing science in every age range from 3 year olds to children of 11. "Science was part of the curriculum in all the Year 1 (5-6 year olds) classes inspected" (HMI Report: The Implementation of the National Curriculum in Primary Schools, 1989, DES).

Research

This period has been marked by publication of research into teaching and learning science with young children. Examples include the DES funded APU and the Leeds University CLIS projects. These projects began to provide evidence of the need for considerable development in the teaching of science particularly in the early years of education. This research must be maintained; the SPACE project at Liverpool will undoubtedly make a significant contribution.

A place for science

Visiting schools as I continually do, I find that whole staffs have developed their use of topics and themes to include science and that often the bias towards science is heavy, perhaps too heavy in some cases. This situation was to be expected and will be affected in three ways:

- With familiarity - as science seemed new, teachers rightly gave extra

Figure 1 Six year old children investigating the arrangement of batteries in various torches
planning and curriculum time to it in order to accommodate it both as part of the curriculum but also within their own understanding of the curriculum.

- In broad curriculum balance - we have yet to receive final statutory orders for history and geography, creative arts, and movement. These areas will require further accommodation in terms of curricular time and emphasis.

- In increased integration - balance is only likely to be achieved when we have more experience 'jigsawing' science into the curriculum.

Rather than being one piece in a jigsaw, science may be seen to be made up of several pieces of jigsaw spread around the picture of the curriculum. It is also present in all other pieces of the picture as science offers a major contribution in all areas of the curriculum.

Challenges

Several elements of curriculum design present themselves as challenges for the end of the century. Cross curricular balance is certainly a major element as is Science 3-16. Science has historically in some cultures been viewed as something for older, academically minded males. In some measure the revolution is that science is for all, male and female, all abilities, ethnic and cultural groups, and that we in education must be clear about what science is and how it fits into the world.

Very practical issues occupy our time at present. How can we create time for all the science (and other areas)? How can we assess, record and communicate achievement? Answers to these questions lie in a range of strategies that focus on developed planning for matching science activities for children, for balance in the curriculum, and for communication amongst the participants - child, parent and teacher.

Undoubtedly science is now occurring in primary schools. The emphasis must now be on quality; judgement of this needs to be based on the level to which children are equipped with the skills and knowledge which will allow them to contribute to our society and to gain fulfilment in life (this may include nationally agreed criteria).

Stepping into Science Newsletter

Teachers actively involved in Stepping into Science are planning to compile and distribute a newsletter containing ideas to try and other information about Stepping into Science. If you would like to contribute, suggest ideas about format and frequency, or have your name added to the distribution list, contact:

Sue Dale Tunnicliffe, Education Department
Zoological Society, Regent's Park
London NW1 4RY, UK
Tel 44-71-722-3333, Fax 44-71-483-4436

The present picture was well summarised by a newspaper headline "On course, but still far to travel". (Diane Hopkins, Times Educational Supplement, 13.10.89, Review of

HMI publication The Teaching and Learning of Science)

Alan Cross is a lecturer in primary education, Manchester University, UK.

Figure 2 (above) Kieron (6 years) represents his circuit in two dimensions

Figure 3 (left) Six year old children investigating the construction of a circuit

25
Elementary my dear Watson
Children and the Scientific Method

Reprinted from the
Newsletter of the Teachers Resource Centre, Vol II No 4
Karachi, Pakistan

The rapid development in technology to store, retrieve, and communicate information has led to changes in educational practice the world over. Teachers are no longer 'feeding' their pupils with a body of knowledge considered appropriate for their age/stage, but teaching them to discover for themselves what they may find useful or interesting.

In our context, a major problem with this approach is that most of us in the teaching profession were brought up on textbooks only. We associate 'study' and 'research' skills with higher levels of education and find it difficult to envisage school children involved in such an activity.

The second problem is our own perception of 'the teacher' as the omnipotent source of knowledge. It is difficult for us to say "I don't know" and to join the children in discovering new things.

Organising 'hands-on' investigation by children is not difficult, provided you are willing to experiment yourself. For instance, the topic 'Fruits' is ideal because, in Pakistan, it is relatively easy to provide children with samples of real fruit with which to begin their investigation.

Let us say that you have given a group of children a melon to investigate. They will need to handle it, look at it carefully, smell and taste it. They can make detailed (eg scientific) drawings of the inside and outside parts and label them. Other fruits may be introduced for similar investigations so that comparisons can be made. Children can begin to draw up charts and graphically record the information discovered (eg the number and shape of seeds, colour and texture of the skin and fleshy parts).

The gathering of information is only part of the activity. The recording can be used as a source for children to make verbal and written conclusions (eg Fruits may have one or two seeds). Thus considerable scientific skills such as observation, recording, hypothesising and concluding can be practised. Sometimes teachers will need to extend an investigation further by raising more questions (eg What happens to the fruit when left outside?). Teachers can encourage children to ask such questions themselves. Books can provide further information about the subject once children have carried out the initial practical investigation.

We hope this small example sparks ideas you can try out in your classroom, bearing in mind that children forget what they are told, may remember what they see, and understand what they do.

I. HYPOTHESIS:
Fruits have one or two seeds.

II. MATERIALS:
A knife, assorted fruits like a melon, some peaches, pears, grapes, bananas; a mango or two, a papaya or a coconut.

III. TEST:
Cut the fruits and find the seeds. Count how many each fruit has.

IV. RECORD:
Draw the fruits and write their names. Under each fruit record the correct size, shape, colour, and the number of seeds.

V. CONCLUSION:
Different fruits can have one or many seeds.

VI. REFLECTION
Have the children reflect on the experiment, and pose questions to them:

Was it a fair test?
"No, because we did not use all the fruits in the world."
"Yes, because we used fruits of different sizes and shapes."

What factors in your experiment should you change?
"Leave out the coconut because it was hard to cut and difficult to see the seed."
"Make sure you cut the fruit in the middle to find the seed(s)."

What might you do next?
"Find out from books about more kinds of fruits."
"Set up an investigation of fruits of the same species and see if they all have the same number of seeds (lemons, guavas, etc.)."
ENGAGING SCIENCE is a resource development project of the Australian Science Teachers Association, and was funded by the Commonwealth of Australia's Education of Girls in Mathematics and Science Project.

The project addresses the significant challenge of how teachers can provide stimulating Science Technology & Society related experiences that engage all students in meaningful and relevant learning.

Some of the guidelines developed by the project are indicated in Figure 2 below.

To engage all students, especially girls, in learning science, material should:

Address something students want to learn about. Therefore it should:
- look at the whole picture
- link science, technology and society
- show science in a human context
- consider social responsibility in science
- be related to 'real' people in 'real' situations
- be 'hands on'

Be considered important to learn. Therefore it should:
- be more than just 'add-ons'
- be assessed using a variety of methods
- illustrate societal concerns and technological concepts as well as scientific concepts
- be challenging to students

Be diverse in the teaching styles used. Therefore it should:
- be interactive
- include cooperative learning styles
- emphasise creativity and problem solving
- include process oriented material
- include open-ended activities
- take account of 'children's science'

Be able to show that physical science can be worthwhile to learn. Therefore it should:
- be achievable
- be fun
- point to career options
- ask - do students need to know this?
- be relevant

Figure 2 Engaging Science Project Guidelines
One of the key considerations was that the material should be
gender inclusive. Because girls in particular seem to lack
interest in the physics components of traditional science
courses, the project concentrated on providing innovative
student and teacher resource materials for two topics with
physical science components.

The first topic is ELECTRICITY. The second topic is
RADIO AND COMMUNICATION. Generally the materials
are aimed at the Year 9 level but can be readily adapted to
suit a variety of year or ability levels, time constraints or
other needs.

The resource materials are designed to go into the teacher’s
own folder (Figure 1) so that the order can be changed and
other materials easily added. This is a ‘mix and match’
philosophy. Possible pathways and lesson outlines are
presented, but these are only suggestions and teachers are
encouraged to modify and adapt the materials to suit the
needs of their students and schools. The resources have many
possible entry and exit points.

As well as being valuable resources in their own right, the
project materials and teachers guide aim to provide a model
that will help teachers to produce their own materials on
other topics.

A key premise of ENGAGING SCIENCE is that science
education can be made more relevant by approaching it from
the perspective of science, technology and society. This is
illustrated by the unit called MUSIC TO THE EARS which
is about noise and how it affects people (see Figure 3
opposite).

To engage all students in science learning requires use of a
wide range of teaching techniques and strategies. Open-ended
practical activities, problem solving, co-operative learning,
and techniques which foster creativity are particularly
encouraged whenever appropriate.

With these strategies teachers aim to set up non-threatening
situations in which students are more likely to take risks,
answer questions and become involved in hands-on activities.
Girls in particular are encouraged to participate in hands-on
activities such as tinkering (Figure 4).

Noise and how it affects people

The scene is set when the teacher asks students to
listen to a variety of sounds. Students then decide
whether each sound is an example of noise or not.
This leads on to groups of students designing a survey
to find out how noisy their school environment is and
the problem of reducing noise pollution.

Students then carry out a ‘jigsaw’ activity on a case
study on issues of noise pollution and the extension of
an airport. They form home groups and then each
member of the home group is involved in a different
expert group. For example, one expert group looks at
the social implications of extending the airport.
Students return to their home groups and develop
‘consequence maps’ for various possible decisions.
Students consider the nature of sound, and examine
amplitude and frequency and the difference between
noise and music. They consider the sensitivity of
animals and also careers in acoustics. From this
follows an examination of the structure of the ear and
causes of deafness. Consideration of the decibel scale
for measurement of loudness leads to work on
logarithmic scales.

Finally extension work is provided on investigating:
noise pollution regulations in the student’s home
state; a local factory or workplace for noise pollution;
how mufflers work; and how ultrasound is used in
medicine.

In the teachers guide, teachers are encouraged to set up
apparatus for testing the hearing of their students.
The study of this unit should:
• increase students’ awareness of the effects of noise
pollution
• increase students’ understanding of sound and its
transmission
• develop students’ communication skills through
debating
• heighten students’ awareness of their social
responsibilities
• provide opportunities for students to practise
information collection and interpretation
• illustrate the application of mathematics

Figure 3 Noise and how it affects people

Figure 4 (left)
In the unit INSIDE A RADIO students can tinker
individually with a transistor radio, exploring its insides.
They are also able to learn how to use a soldering iron and to
investigate any questions that arise from their tinkering.
The unit QUICK AS A FLASH considers lightning to explore aspects of electricity. It then leads to a problem solving activity in which students as a group have to decide the most appropriate action in the event of a lightning storm. The scene is set:

"Imagine you and three friends have been camping in the country. After lunch you fall asleep in the warm sunshine. You awake several hours later to the sound of a loud crash. The sun is hidden by a huge thundercloud. You see a flash of lightning . . . "

With the storm rapidly approaching from the East, pupils are asked to decide in a group their course of action (Figure 5). Their decisions can then be discussed and questions which are generated can be classified and investigated further.

ENGAGING SCIENCE aims to help make science education more effective and relevant, and lessons more enjoyable for students and teachers alike.

Further details

Further information is available from Elizabeth Dangerfield, 39 Webster Street, Hughes ACT 2605, Australia.

About the author

Elizabeth Dangerfield, Project Officer of the Engaging Science Project, is a Science Consultant for the ACT Department of Education. Elizabeth, active in the work of science teachers associations, has recently been elected as Secretary of the Australian Science Teachers Association.

AN EXERCISE IN SURVIVAL

You are in the middle of a large, flat paddock as shown below. A storm is approaching rapidly from the east. The lightning is very loud and bright. How much time have you got before the storm is overhead? What are you going to do?

1. In a group, decide upon the most sensible plan of action. Write down your plan, explaining the reasons behind your actions.

2. Did you have all the information you needed to make a sensible decision? What more would you have liked to know? Often we have to make decisions on incomplete evidence. The more background information you have, however, the more likely your decisions will be the best possible in the circumstances.

Figure 5 Part of student worksheet for Quick as a Flash
NEW ICASE PUBLICATION

Bibliography of Science and Mathematics Education Software

This bibliography (63 pages) has been created by ICASE based on information about software in science and mathematics in Asia and Australasia and sponsored by Unesco. It is a followup to a bibliography created in 1986 in conjunction with an Asian seminar on the use of microcomputers in science and mathematics teaching. The publication lists (1) institutions, by country, engaged in the production of computer assisted materials for the teaching of science; and (2) computer software categorised in the areas of biology, chemistry, earth science, environmental science, general, mathematics, physics, and (general) science.

Further details are available from:
Dr Jack Holbrook
Executive Secretary, ICASE
Department of Curriculum Studies
University of Hong Kong
Hong Kong

International Newsletter on Chemistry Education

The Committee on the Teaching of Chemistry of the International Union of Pure and Applied Chemistry (IUPAC) publishes International Newsletter on Chemical Education in co-operation with Unesco. The newsletter is published in English twice a year, in June and December.

It contains news of international events in chemistry education, and articles from a variety of countries. Further information is available from:
Mr P J Towe
Centre for Studies in Science and Mathematics Education
University of Leeds
Leeds LS2 9JT, UK

Science Leadership Trend Notes

The National Science Supervisors Association's LISE Center is initiating a new newsletter resource for subscribers. Science Leadership Trend Notes, to be published six times a year, will contain the latest initiatives, trends, facts, events and networking connections essential to developing effective science programs, and relevant to all those holding supervisory positions in science education.

Send a subscription request with US$12.00 to NSSA's LISE Center, Suite 227, Copernicus Hall, Central Connecticut State University, New Britain, CT 06050, USA.

Energy: Economic Awareness and Environmental Education

This resource pack encourages investigative, process-led approaches to environmental issues. The pack is based on nine units that have been developed in association with teachers and trialled in schools. It consists of:

• copyright-free student resource sheets suitable for the 11 to 16 age range
• teachers' notes with checklists and guidance on possible uses of the resource sheets and expected outcomes of the activities
• extracts from magazines and journals that relate to the energy issues raised in the student materials.

The resource pack, recently published by the World Wide Fund for Nature, is available, price £12.95, from:

World Wide Fund for Nature
Panda House
Weyside Park
Godalming
Surrey GU7 1XR, UK
ICASE is keen to arrange regional or world events for the benefit of member associations. If your association or organisation is interested in hosting an international seminar, workshop or conference, contact the Executive Secretary or your Regional Representative. To gain ICASE endorsement, the meeting must be international in nature, open to member associations, and, while all sectors of the science education community should be encouraged to participate, must be relevant to classroom teachers.

1990

September 5-7
ICASE European Symposium on Industry and Education
Location: Brussels, Belgium
Contact: Drs Jan Hendriks, ICASE European Representative, Konijenpad 3, 7921 BM Zuidwolde (DR), Netherlands
This Symposium involves education representatives from member associations of ICASE and industry representatives invited by Conseil European des Federations de l'Industrie Chimique (CEFIC). The Symposium will (1) provide opportunities for the exchange of information and experiences in schemes for industry-education liaison, (2) develop models for industry-education liaison, (3) establish a network for information exchange for future developments, and (4) publish a resource book for teachers and administrators on industry-education liaison.

September 10-20
Seminar on STS Education
Location: University of Oxford, Oxford, UK
Contact: The Director, Courses Department, The British Council, 65 Davies Street, London W1Y 2AA, UK
The British Council is conducting a seminar on "Science Technology and Society Education: Developing a Relevant Science Education for the Future". The seminar will consider a wide range of educational issues which arise when science and technology are taught in the context of their social interactions. The following topics will be considered - rationale for STS, developing new curriculum materials in schools, innovations in teaching STS, research into STS in the classroom, studying the environment, ethical and gender considerations, monitoring changes in new technology, media influence on our students' ideas, and the way forward.

This conference, endorsed by ICASE and the Canadian Association for Science Education, and hosted by the Science Teachers Association of Manitoba, will focus on the theme "Sustainable Development Strategies - The New World Agenda". The conference will enable participants to examine and discuss the links that must be fashioned so as to integrate environmental concerns with continued development on the energy, resource and economic fronts. The program will address the role that curriculum, teachers and schools can play in helping students understand the environmental realities which are the cornerstone of sustainable development. An International Symposium on Sustainable Development will precede the conference on October 15-17. Representatives from education, government and industry will meet to examine the implication of sustainable development upon the curriculum.

November 7-11
NABT Annual Meeting
Location: Westin Galleria & Westin Oaks Hotels, Houston, Texas, USA
Contact: National Association of Biology Teachers, 11250 Roger Bacon Drive, Reston, Virginia 20209, USA
The theme of this conference is Planet Earth in Crisis. A feature of this year's program will be contributions by international participants and an international reception.

December 12-14
ASPEN Meeting on Demonstration Experiments and Computer-Aided Learning in Physics
Location: Pune, India
Contact: Prof Arun Nigavekar, Physics Department, Poona University, Pune, India

December 27 - January 1
International Conference on Teaching of Physics
Location: Karachi, Pakistan
Contact: Mrs Aziz F Hasnain, Head, Department of Physics, APWA Government College for Women, F 'B' Area, Karachi, Pakistan
The theme is The changing face of physics education in developing countries. The conference aims to discuss techniques for conceptual teaching in physics, to create awareness among physics teachers about modern teaching methods including the use of computers and audiovisual aids, and to establish a research program in physics education.
1991

January 4-7
ASE Annual Meeting
Location: University of Birmingham, Birmingham, UK
Contact: Annual Meeting Secretary, ASE Headquarters, College Lane, Hatfield AL10 9AA, UK
Full details of this large international event will be circulated with the September issue of Education in Science, the journal of the Association for Science Education. A special feature of this meeting will be an ICASE Symposium. Non-members of ASE and those outside the UK who wish to receive details should write to the contact above.

March 27-30
NSTA National Convention
Location: Houston, Texas, USA
Contact: Linda Crow, Asst Professor, Baylor College of Medicine, One Baylor Plaza, Room 633E, Houston, Texas 77030, USA

March 29 - April 3
7th ICASE-Asian Symposium
Location: East China Normal University, Shanghai, China
Contact: Prof Mi Zihong, Department of Physics, East China Normal University, Shanghai 200062, China
The symposium will be conducted in English/Mandarin and will address the theme Making science education in schools more relevant. The program will focus on (1) the development of appropriate curricula, the issue of integrated science vs separate sciences, the introduction of STS in science courses; (2) innovations in teaching, the role of project work, the teaching of science communication skills, low cost equipment, fieldwork; (3) technology in education, the effective use of visual aids, visits to industry, the place of the computer; and (4) research in science education, children's learning in science, assessment techniques. The program will consist of presentations by internationally renown science educators; papers, workshop and discussion sessions; poster displays; and an exhibition. Write to the above address for the second circular. Titles and abstracts of contributed papers should be sent to Prof Mi Zihong by 31 October 1990.

July
GASAT 6 International Conference
Location: University of Melbourne, Victoria, Australia
Contact: Ms Gaell Hildebrand, School of Education, University of Melbourne, Parkville, Victoria 3052, Australia

August 4-9
ChemEd 91 Conference
Location: Oshkosh, Wisconsin, USA
Contact: Bruce G Smith, Co-Director, Appleton High School-West, Appleton, Wisconsin 54914, USA or Paul Kelter, University of Wisconsin, Oshkosh, Wisconsin 54901, USA
ChemEd 91 is a major chemical education conference of interest to university, college, secondary and elementary educators from North America and beyond. Throughout the weeklong conference, activities are planned for all members of the family including excursions, field trips, sports activities and social events - a feature of ChemEd conferences.

August 25-30
11th International Conference on Chemical Education
Location: University of York, York, UK
Contact: Dr John F Gibson, ICCE 11, Royal Society of Chemistry, Burlington House, Piccadilly, London W1V 0BN, UK
This biennial conference on the theme Bringing Chemistry to Life is being organised by the IUPAC Committee on Teaching of Chemistry in conjunction with UNESCO and the Association for Science Education. The conference will focus on (1) making chemistry accessible to all students (2) new curricula at primary, secondary and post-secondary levels (3) new teaching strategies at all levels (4) teaching and learning at a distance (5) new frontiers of chemistry and their impact on teaching, and (6) research in chemical education. The program will include plenary lectures, poster papers, symposia, workshops, exhibitions, times for participants to discuss aspects of chemical education of special interest, social events and local visits. A first circular detailing the broad program and how to contribute is available now. The second circular will be published in October 1990.

August 26-30
Fourth Asian Chemical Congress
Location: Beijing, China
Contact: Prof Dehe Zhang, Secretary General of 4ACC, Chinese Chemical Society, PO Box 2709, Beijing 100080, China
The 4th Asian Chemical Congress will be held under the sponsorship of the Federation of Asian Chemical Societies. The Congress will focus on the important role of chemistry in raising the health conditions and living standards for all people. The program of plenary lectures, invited papers and contributed papers will be conducted in English and will concern various topics including organic chemistry of natural products, analytical chemistry and instrumentation, environmental chemistry, agrochemistry, coordination chemistry and its applications in medicine and agriculture, polymer science, photochemistry, computers in chemistry, catalysis, and chemical education.

August 27 - September 1
5th International Environmental Education Conference
Location: Cusco, Peru
Contact: MSc Eduardo Gil Mora, National University of Cusco, Zaguanc del Cielo L-9, Cusco, Peru
The conference will focus on the relationship between the environment and development, and on the changes needed in today's behaviour for tomorrow's world. The program will enable participants to learn of developments, approaches and strategies in environmental education in different countries, and will cater for primary, secondary and tertiary educators; and for teacher trainers, curriculum developers, and policymakers.
ICASE News  
Feature Articles  
Process-Based Learning for Pupils and Teachers: The work of an international project in primary science Wynne Harlen 
Trends in K-12 Science Education in West Africa Duro Ajeyalemi  
Science Education Around the World  
Research for Teaching and Learning  
Field Work in Secondary Science Tom Schnoebelin  
Profile  
Children & Youth Science Center  
Primary Science  
Science Technology Society  
STS as a Development in Science Education Robert Yager  
Resources  
Calendar  

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Science Education Center, University of Iowa, Iowa City IA 52242, USA  
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10 Hawken Street, Monash ACT 2904, Australia  
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Jack Holbrook, ICASE Executive Secretary  
Department of Curriculum Studies, University of Hong Kong, Hong Kong  
Individuals HK$120 per annum, Libraries HK$240 per annum
Change of Address for ICASE Secretariat

Please note that Dr Jack Holbrook, ICASE Executive Secretary, will be on leave in the UK during most of 1991. Direct all correspondence for Dr Holbrook to the address of the Honorary Treasurer of ICASE:

ICASE Secretariat
c/o Dennis Chisman
Knapp Hill
South Harting
Petworthfield GU31 5LR
UK

ICASE Symposium on Industry-Education Liaison

by Dr Jack Holbrook
Executive Secretary, ICASE

This symposium, held in Brussels, Belgium during 5-7 September 1990, was attended by 54 participants from Europe, America and Australia. Support was provided by CEFIC (Conseil Europeen des Federations de l'Industrie Chimique) and EPCA (European Petro-Chemical Association).

The program featured presentations of different patterns and strategies involving liaison between education and industry. While most of the presentations were made by educationalists, ICASE was greatly encouraged by the support shown by delegates from industry, both in their joint presentations and in their comments on the various models proposed.

The Chemical Industry Education Centre at the University of York, UK, was presented as a useful mechanism in meeting the needs of school science teachers by providing both a bridge between science teachers and chemical industries, and a means by which appropriate resource materials can be developed for and disseminated to science teachers.

The Cologne model: Chemistry - Technology, Daily Life, Inservice Training and the Interplay of the Elements of Science, Technology and Everyday Routine in Schools is an inservice training project in Germany in which there is intensive cooperation between teachers and university and industry representatives, both in the planning and implementation of events and in the development of materials.

The Colorado Alliance for Science, now in its eighth year, is an action-oriented consortium of school districts, businesses, industries, colleges and universities, researchers, science-related associations, and government agencies in Colorado, USA. This is an effective way of bringing the community together, and examples of alliance activities include: Visiting Scientists Program; the RESETT (Retired Educators, Scientists and Engineering Task Team) Program; Hotline (a link for all teachers with government, university and private sector personnel); and the Summer Fellowship Program for science and maths teachers, providing opportunities for teachers to work in an industrial, university or government agency setting during the summer.

The Triangle Coalition for Science and Technology Education in the USA consists of 95 national organisations in the business/industry, science/engineering, and education areas. Activities include a National School Volunteer Project, and a Summer Industrial Fellowship for Teachers Project. It has become an umbrella organisation for community action groups.

In an Activity-Based Industrial Visit Program in Finland, students are divided into small groups to make minor investigations closely linked to the school syllabus. The industry link is carefully planned as the activities in the plant are run by its staff. Teacher education has had an essential role in creating the model, but drawbacks are the traditional cultures in schools and in industry.

Kemira, in Finland, has developed a more formal program of plant visits which involves young people in a totally different way. Before the visit, a company representative goes to the school and pupils undertake preparatory work. During the visits, students are involved in laboratory tasks in small groups under the supervision of professional personnel. After the visit, reports are written and then presented in a final session on the company premises to which parents are invited.

The French chemical industry has cooperated with secondary schools for many years by organising talks by engineers on chemical processes, by plant visits, and by twinning schools and companies. In 1984, French National Chemistry Olympiads, in which students compete, were initiated. At the first level, talks, laboratory work and plant visits were organised using one of the major application fields in chemistry as the theme. From each district, a representative was selected to compete in a national competition involving a general paper,
laboratory work and an oral debate. The olympiad is an initiative of Elf-Aquitaine (the French Chemistry Industry Union), Union des Physiciens (Association for Teachers of Physics and Chemistry), and personnel from universities and 'Grandes Ecoles'. Its objective is to offer an experimental component to chemistry teaching, and to develop a closer relationship with industry.

The ClI (Confederation of Irish Industry) Education College, set up in Ireland in 1984, is a trust channeling funds from industry into education projects. It supports activities such as teaching materials (booklets, posters, videotapes). The Irish Science Teachers Association has been instrumental in the setting up of the ClI Education College and in promoting cooperation between education and industry in general. The Schools Information Centre on the Irish Chemical Industry has produced a directory of the Irish chemical industry for teachers, and is collecting information on teaching resources available from chemical industries overseas.

A distinguishing feature of Swedish schools is their focus on working life. Instruction on local employment begins at the junior level when students can go on field trips to workplaces and visit their parents at work. During compulsory schooling, students must complete at least 6-10 weeks practical working life orientation. The students' choice of practical work experience must be combined in such a way that boys become acquainted with at least one occupation where women dominate. Many municipalities have begun to build up technical resource centres operated jointly by schools and industry.

The role of the Royal Society of Chemistry in the UK in promoting industry-education links can be illustrated by its various initiatives including project weeks, 'hands-on' symposia for teachers, chemistry at work exhibitions, and industry study tours.

The industry study tours are residential conferences for teachers - planned, organised and operated jointly by teachers and industrialists. The tours are approximately 4 days in length and include large and small group visits to several sites, talks and discussions led by both educationalists and industrialists, consideration of syllabus and curricula implementation, and workshops in which participants are required to produce the first draft of industry-based teaching material for possible use in their school or college.

Symposium proceedings, which will include a list of participants, will be published soon, and will be available from the ICASE Secretariat. Thank you to Drs Jan Hendriks, the European Representative for ICASE, for his work in organising a very successful symposium.

Extension of Due Date for
Who's Who in Science Education
Around the World

The deadline for entries in this new ICASE publication has been extended to 31 December 1990. This additional time will enable ICASE to invite more prominent science educators, particularly in developing countries, to complete a profile on themselves and their work.

The information in Who's Who in Science Education Around the World 1991 Edition will help you to contact colleagues in both developing and developed countries who may be working on projects of interest to you, who may be potential speakers at your next meeting, or who may be invited to work on collaborative projects.

New member of ICASE

The European Youth Science Network (EURYSN) has recently joined ICASE. This network is an international network which provides a forum within Europe for organisations and individuals involved in the area of youth science. Refer to the September issue of Science Education International for more details about EURYSN.

For further information, write to:
Mr Martin Brady
Coordinator, EURYSN
37 North Great Georges Street
Dublin 1, Ireland

Join us in Houston

The US National Science Teachers Association meets in Houston, Texas, 27-30 March 1991. You are invited to participate in the Fourth Annual International Round Table. Each country is provided one or more tables in a large room where you can display and present information on science education in your country. While NSTA cannot offer funding, an official letter can be provided inviting you to make a presentation. Contact:

Prof John Penick, Science Education Center
University of Iowa, Iowa City IA 52242, USA
Process-Based Learning for Pupils and Teachers
The Work of an International Project in Primary Science

by Wynne Harlen

The activities described in this paper involve a group of science educators from different countries working together intermittently to improve primary science teaching through teacher education. In a nutshell, what has been done is to gather together the best of the ideas of experienced teacher educators and to pass these on to other teacher educators. But it is the way in which this has been done which gives the project its unique character. It has taken seriously and acted upon the view that to improve learning opportunities in the classroom requires teachers to change practice, and this in turn requires change in teacher education, both pre-service and in-service. Furthermore, its view of learning with understanding as change in ideas and skills, which is brought about by the learner's own mental and physical activity, has been consistently applied to the learning of children, teachers and teacher educators. The idea of attempting to change teachers by simply telling them about approaches to classroom practice is regarded as unprofitable, and sometimes damaging, as expecting young children to learn science by straight transmission of facts and procedures.

The rationale for the project

In 1985, on the initiative of the Commonwealth Secretariat and Unesco, a small project was set up which had short, medium and long-term aims:
- In the short term to bring together a small group of educators with expertise in primary science to plan a training workshop for teacher trainers and prepare draft materials;
- In the medium term to bring together teacher trainers, mostly from Third World countries for workshops using the approach exemplified in the materials;
- In the long term to collect together and develop further workshop materials for use in pre-service and in-service courses and make them available to teachers and those providing courses for teachers.

The focus of the project on teacher education is not difficult to explain. It is not just in countries of the Third World that primary teachers lack confidence in themselves in teaching science and perceive themselves as not having enough background knowledge. This is an almost universal problem and one which can only be tackled through teacher education.

An international project could perhaps entertain the ambition of having an effect at this level and it was recognised that the target must be teacher educators rather than teachers.

The activity of scientists . . . is not all that different from the activity of children

A second focus of the project, process-based learning, perhaps needs more justification. It is important to give the reason since it is fundamental to the view of learning and of science from which the work developed. It stems from a view of science as being about understanding the physical and biological world around. The activity of scientists developing further understanding at the frontiers of knowledge is not all that different from the activity of children finding out about the world around them. Both the scientist and the child, in trying to make sense of new events or objects, begin from relevant existing knowledge and ideas, and test the extent to which new phenomena can be explained using these existing ideas. If predictions based on a related existing idea fit the new observations, then the range of applications of the idea is extended; if the evidence does not fit the prediction, however, this may mean that the idea has to be modified or rejected in the light of the new evidence.

The use and testing of existing ideas involves the processes of science. It is through processes such as observation, question raising and hypothesising that existing ideas are brought to bear in trying to explain new evidence; it is through processes such as prediction, planning, experimenting and interpreting that conclusions are drawn as to whether the ideas fit the evidence. But if these processes are not carried out in a rigorous and scientific manner, then the emerging ideas will not necessarily fit the evidence. Ideas may be accepted which ought to have been rejected, and vice versa. Thus development of ideas depends crucially on the processes used.

It is in the extent to which the process skills are scientifically rigorous that children's learning activities differ from those of scientists. We know that children often observe superficially, looking for confirmation of their ideas rather than being open-minded in using all the evidence available; we know that their first attempts at prediction are really based on what they already know to be the case, rather

It is not just in countries of the Third World that primary teachers lack confidence in themselves in teaching science . . .

In working to achieve these aims, the project drew on what was already being attempted in teacher education by a small sub-committee of the Committee on Teaching of Science (CTS) of the International Council of Scientific Unions (ICSU). What is described here owes much to Jos Elstgeest from the Netherlands who, with myself and Emmanuel Apea, has seen the project through from the beginning to the present.
than being true predictions; the tests they carry out are often far from being 'fair' or controlled; they rarely check or repeat observations or measurements. Just as their ideas or concepts are limited and immature, so are their process skills, and both are capable of development. The dependence of concept development on the way in which ideas are tested, that is, on the use of process skills, provides one part of the rationale for the importance of developing these skills. It is perhaps worth emphasizing that the case for attention to process skill development is in terms of the role of these skills in concept development. Concept development is being served and not ignored by this focus.

A second part of the rationale for giving attention to process skills is implicit in the type of learning just described. This is learning in which the learner collects the evidence and does the reasoning; makes the ideas his or her own. This is what we may call learning with understanding. Learning without understanding, as in rote memorization, does not require the use of process skills. We need not linger long on the faults of rote learning, but it is worth observing that much science was (and probably is) taught in a way which leaves pupils little option but to learn facts by heart. This leads to science being regarded as a mystery, as not making sense and as having nothing to do with understanding the world around - the opposite of our aim in science education. Moreover we want pupils and future citizens to feel at ease with science, to know its strengths and weaknesses, even if they are not practising or directly using science, and the best way of achieving this is through the experience of finding things out and the realisation of how ideas emerge from human activity.

The way of learning just described - developing one's own understanding by testing and modifying existing ideas in such a way as to engender 'ownership' of the new ideas - is appropriate to all kinds of learning and to all learners, not just to children. Education of teachers requires change in their ideas about teaching. If they are already practising it is often necessary to produce a quite radical change in their view of what teaching is and how children learn. This will not happen quickly and without some considerable effort on the part of those concerned. In the case of teachers in initial training, the position is not so different from that of practising teachers; these aspiring teachers will have spent up to 12 years in school through which they will have developed quite firm ideas about teaching and learning which may well have to be changed.

So in teacher education we are concerned with changing ideas, not just planting new ones on virgin soil. To do this in relation to the teaching of science for primary teachers encounters particular problems. Many, perhaps most primary teachers have received from their own education a legacy of failure or at least dissatisfaction in relation to science. Thus the over-riding requirements of teacher education are to develop confidence, an appreciation of the nature of scientific activity, and enthusiasm for teaching science. These pervading aims have profound implications, for they concern attributes which cannot be engendered through specific content but only in the way of dealing with that content (for example, by not lecturing to a large group of students as the predominant style of a course).
and improvisation of equipment;

- Ability to handle children's questions, to encourage and use children's interests;
- Ability to assess children's performance and to evaluate the success of teaching and learning.

Whilst all of these are important, some are more fundamental than others. It has been argued (Harlen & Osborne, 1985) that, given some freedom of action, teachers tend to teach according to their view of learning and of the subject. Thus a teacher who regards learning as resulting from clear exposition on the part of the teacher and science as a set of facts and procedures to be memorised, will teach in a way which maximises opportunities for children to attend to sources of accurate information. If the teacher's view of

However good a teacher is at class management, learning depends on what the teacher sees as being required for learning

learning is the one suggested earlier, where the learner is active in creating understanding, testing ideas on the evidence of materials and events around, then the classroom provision will clearly be very different. This argument leads to the conclusion that the first two ideas on the list above are pre-eminent. However good a teacher is at class management or at assessing children, the learning that is managed and assessed depends on the quality of the experiences provided and this depends on what the teacher sees as being required for learning. Moreover, it has to be admitted that taking account of children's own ideas and providing opportunities for them to be tested using process skills is very demanding, despite its rewards. Thus, only when teachers are convinced of the value of active, process-based learning, will they be prepared to make the effort to organise the class, the materials and the time for children to learn in this way.

For these reasons the project gave priority to ensuring that teachers have experiences which lead to the understanding of the nature of scientific enquiry and of active learning. The experience of active learning is the only way of understanding what it means and, moreover, invariably creates the excitement and enthusiasm for science which few teachers have managed to acquire from their own school education. To help children learn in this way it is necessary to understand, not just at an intellectual level but in terms of practice, what it means to carry out observation, to hypothesise, to make a prediction, to plan an investigation, and so on. This is a tall order for those who may never in their own education have had an opportunity to create and test a hypothesis based on their own ideas. So important experiences for teachers or student teachers involve them in doing some science activities, at their own level, but in the way in which it is hoped they will provide for their children.

After experiencing learning in this way, the adult learners can stand back and consider what they have been doing and how they have been learning. They are in a position to realise the advantages of this way of learning and to develop some commitment to making it available for children. This is the essence of what has been described as a 'worship' approach to teacher education, whose characteristics are (Unesco, 1984, Document 13, pp 8-9):

- The participants are active, both mentally and physically. They are involved in experiencing the kind of learning that is being advocated for children, in reflecting, in analysing, in creating;
- The messages that are conveyed are not transmitted by direct telling but through active involvement;
- Through handling materials for themselves the confidence is gained that is necessary to providing similar experiences for children;
- Understanding is achieved by each participant from within rather than from outside; it comes through reflecting on direct experiences and on new ideas which may be presented for discussion;
- The product is not knowledge of a set of specific activities for children to do but an appreciation of new kinds of learning and some of the many ways of bringing this about in children.

This way of learning does not have to be restricted to developing personal knowledge of science. It can, and should (to reinforce the value of learning this way) be applied to all the learning experiences which were listed earlier. It means starting from the ideas which are already present and working with the learner/teacher, making use of evidence (from previous experience and logical argument as well as direct observation, since we are dealing with adults) to change them. Working in this way has a double benefit, in bringing about re-education relating to the nature of learning and, at the same time, being the most effective way for teachers to

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learn the skills and abilities required for effective science teaching.

The group context of the activity enables discussion to turn to analysing the role of process skills and concepts in their learning, to reflecting on the sorts of activities which encourage use of these skills and concepts, to considering the teacher's role in these activities, and to identifying the range of class organisation, strategies and resources which are required. Thus the other items on the list of teachers' needs are covered by further workshop activities.

As an example, ways of dealing with awkward questions from children (a situation which is at the heart of many teachers' lack of confidence) are addressed in the following activity. There is first a discussion of children's motives for asking questions and a rough categorisation of the kinds of questions they ask. Teachers working in groups then reflect on one of the science activities they have done previously and draw up questions which they consider 'difficult' for a teacher to answer. Each group then passes its difficult question onto another group who attempt to categorise it and to suggest how to respond to it. Usually there are several alternatives put forward within the group as a result of often heated discussion. In a plenary session, all groups in turn read the questions handed over to them, give their suggested responses and their justification for their preferred response. The group originating the question is asked to comment on how satisfied they are with the response and other groups join in. While no firm formulae for answering questions can be given, there emerge from the discussion guidelines for responding to different kinds of questions. Often the best response is not to provide an answer, but to turn the question so that it leads to further enquiry by the child. Thus the responses are termed ways of 'handling' questions rather than answering them. The important thing is that they are the product of the thinking and arguing of the teachers themselves and what emerges are their ideas (further discussion of handling questions can be found in Jelly, 1985).

Progress towards the project's aims

The project's activities have made progress towards all three aims listed at the beginning of the article. There was a small international seminar held in Liverpool in December 1986, which thrashed out the basic philosophy and planned the first workshop for teacher trainers. An international workshop, achieving the second aim, was held in Barbados in 1987, with the support of ICASE and the British Council as well as the Commonwealth Secretariat and Unesco. Several of the participants later ran workshops in their own countries. In addition there was a South East Asian Regional Workshop in 1989 and an African Regional Workshop in 1990. Achievement of the third aim is taking the form of a new Unesco Handbook, to be published in 1991.

It is well recognised that many Third World countries are a considerable distance from being able to implement the ideas in their intended form. For many, the project indicates the direction of progress even though they may be able to take only a small step in that direction at the present time. It is also realised that supporting materials, such as are being produced, are only part of the story. Teacher trainers in many countries will not have any experience of primary school teaching and will themselves require a good soaking in the workshop approach before they can effectively use the materials which are being made available.

There is resistance to a process-based approach to teaching science

Another pervading problem is the pressure of time; time in the training programs and time in the school programs for this way of working. Commonly there is resistance to a process-based approach to teaching science simply because of the type of syllabus which a teacher is required to cover. Perusal of these syllabuses generally shows the potential for reorganisation into far fewer items which focus on key concepts, rather than the multitude of separate facts often bearing little relationship to the children's immediate environment. It is possible to adjust syllabuses or curricula in ways which still meet statutory requirements but make room for children to take part in their learning.

To change assessment is perhaps the swiftest way of promoting change

Finally, the role of assessment - a factor often inhibiting change in schools and therefore in teacher education programs - must not pass unmentioned. Assessment methods and criteria have to be consistent with the aims of learning if there is to be any chance at all of implementing changes in children's learning experiences. It is no longer the case that process skills and understanding (as opposed to factual knowledge) cannot be reliably assessed. The techniques exist and examples are readily available. To change assessment is perhaps the swiftest way of promoting change, if those responsible for it are willing to do so.

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Trends in K-12 Science Education in West Africa

by Duro Ajeyalemi

Of the 15 countries in the Economic Community of West African States (ECOWAS) region, five (Nigeria, Ghana, Sierra Leone, Gambia and Liberia) are English-speaking. All except Liberia were colonies of Great Britain, and so share a common heritage of Western education from Britain. For example, all have a centrally controlled educational system with English as the language of instruction at all levels; uniform standards of curriculum content and assessment at the secondary level; and until recently, a 6-5-2-3 educational structure like Britain.

Illustrated mainly with data from Nigeria and Ghana (the two largest), this paper summarises trends in K-12 science education in the last decade in the British West African countries, drawing implications for the 1990s. Issues discussed include the objectives, curriculum content, the students, the teachers, classroom implementation, and assessment procedures. The trends in the French-speaking West African countries would likely resemble those in France; and those in Liberia were more American until recently, when Liberia harmonised its educational system with those of other English-speaking countries in the region by joining the West African Examinations Council (WAEC).

Background

From the late 1800s when formal science education became part of the school curriculum until the mid-1960s (even after independence), science education in British West Africa was totally patterned after that in Britain, except that little or no science was taught in elementary schools. For example, West African students studied the flora and fauna of Britain in biology instead of organisms in their own environment, and all secondary school subjects were assessed by either the London, Cambridge, or Oxford General Certificate of Education Examination Board. Even WAEC, established at the end of the 1950s to take over the functions of the British Examination Boards in the region, based its examinations on the syllabuses of the British boards until the mid-1960s.

The post-Sputnik science curriculum reforms in the Western world certainly influenced developments in West Africa. Mainly at the behest of science teacher associations in these countries (including the Science Teachers Association of Nigeria, and the Ghana Association of Science Teachers), many new elementary and junior secondary science programs similar to those in the West, but adapted to the local environment, were developed (eg the African Primary Science Project, and the Nigerian Integrated Science Project). For the senior classes of the secondary school, the WAEC developed new syllabuses in biology, chemistry, general science, health science, and physics. All these programs suffered the limitations of their counterparts in the West, including:

- Unsuitability of the secondary curricula for the majority of students not desiring a career in science or science-related occupations, due to emphasis on the structure of the disciplines;
- Incompetence of the teachers in the use of the recommended inquiry methods of teaching and learning.

Teaching emphasised information-giving, was textbook-bound, and was carried out essentially through the lecture method

In addition, most secondary students had weak backgrounds in elementary science and were not motivated to study science either through any government policy or their experience of science in schools. In all the countries, provision of laboratory facilities for science teaching at all levels was not only inadequate but what was provided was not used by teachers, either for reasons of incompetence, large class size, pressure to cover apparently over-crowded syllabuses, or other related reasons. Teaching emphasised information-giving, was textbook-bound, and was carried out essentially through the lecture method. Learning was through rote memorisation of presented information, and assessment through WAEC examinations encouraged more the recall and regurgitation of memorised knowledge. In summary, education in West Africa, particularly in science, was generally academic and elitist, emphasising and glorifying the acquisition of knowledge and certificates, yet totally unrelated to the world of work and/or the immediate needs of students and societies.

By the mid 1970s, the general dissatisfaction with that type of science education led to a review of the systems in four countries. A new structure and content of education was formulated in Ghana in 1974 (Republic of Ghana, 1974), and by 1977 Nigeria had launched a new policy on education (Nigeria, 1981). By these policies, the structure changed from the British 6-5-2-3 system to 6-3-3-4, similar to the American system where students spend six years in elementary school, three years in junior secondary (JS), three years in senior secondary (SS), and four years in higher education of varying types. Of greatest importance were the changes in curriculum objectives, content, and assessment methods. Attempts were made to make the curriculum more functional while continuous assessment in the three domains of educational objectives was introduced at all levels of education. For example, integrated science, introductory technology, and pre-vocational subjects (eg home economics, business studies) became essential components of basic education up to junior secondary, the terminus for a majority
of students, especially those who are not academically able. This is to prepare students, at least minimally, for the world of work.

Changes in the Curriculum

Both elementary and JS integrated science curricula now require students to acquire appropriate science process skills, attitudes and thinking skills, but not a great deal of knowledge. The rationale is that the majority of students do not develop as scientists, but require these skills and attitudes, more so than knowledge, for coping with and solving problems in everyday life. The suggested content, still an adequate foundation for students with ambitions in a science career, is derived from the students' local environment. Topics such as the human body, earth and sky, electricity, light, heat, air, health and safety, plants and animals, and water are now studied in a local context.

The curricular shift to scientific literacy embracing science, technology and mathematics and their impact on society is now noticeable in West African science education

Science at senior secondary is meant for the academically able who elect to study science subjects. Here, students prepare for advanced studies in science while developing their problem-solving skills and desirable attitudes. Science content is emphasised as much as process skills, stressing the application of both content and skills in problem-solving (Nigeria, 1985). Thus, the observed curricular shift from an emphasis on the structure of the disciplines to scientific literacy embracing science, technology and mathematics and their impact on society as found in most developed countries, is now noticeable in West African science education. What may be difficult to implement in West Africa (where curriculum content is specified and centrally controlled), is the recommended instructional approach, which most often demands that students' questions dictate the lesson content and presentation. Research on appropriate instructional strategies for achieving these objectives are needed in the West African region.

One clear difference between the K-12 science education systems in West Africa and that of the US is that the curriculum in West Africa (as in France, Japan, Australia, and recently the UK) is standard for all students while in the US there is a large degree of autonomy from one teacher to the other, one school district to the other, and from one state to the other in what is taught. Students in some US schools may even decide their own curriculum. Perhaps the poor performance of American students in the last IEA study is attributable to the unfettered freedom to choose what to teach and/or learn. On the other hand, a rigidly specified curriculum as found in West Africa puts the teacher under intense pressure to rush through the curriculum in time for the final examination, and leaves little room to manoeuvre or cater for students' real interests. Graduates from such a system may have only learned science as pure knowledge and not as thought, action and attitudes. Perhaps the approach of the AAAS in its Project 2061, of providing a framework of minimum knowledge, skills and attitudes required of all Americans to be scientifically-literate, and encouraging schools to develop their own curriculum based on the framework, is the needed mid-way between the two extremes.

West African children are as curious and intelligent as children anywhere in the world and so are capable of learning science right from kindergarten. However, certain factors in their environment militate against the full utilisation of these innate capabilities, particularly for learning science. These could be grouped into:

(1) cultural factors: language difficulties (both students and teachers are not mother-tongue speakers of English, the language of instruction); poor and non-supportive home environments for the majority; absence of needed facilities and absence of a scientific culture; prevalence of superstitious beliefs which inhibit scientific reasoning patterns; and an authoritarian culture which inhibits the development of students' questioning skills because children are most often forbidden to question the wisdom of an elder, the teacher in this case.

(2) school factors: inadequate provision of science teaching resources, both human and material, including textbooks; large number of unqualified teaching and support personnel; the prevalence of the lecture-recitation method of teaching; and ineffectiveness of monitoring of supervision systems.

(3) societal factors: inadequate public support manifested in the low prestige and reward system for professionals in science; and relatively low government investment in science education and society's indifference to this.

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Even though the number of students selecting optional science up to the end of secondary education is increasing every year as indicated by the number registering for the final West African School Certificate Examinations (WASCE), quality and success rate in the WASCE show a decreasing trend (Ajeyalemi, 1987). Generally students will learn by rote, in response to the didactic teaching methods commonly used by teachers. Although they continue to demonstrate favourable attitudes toward science in the face of all odds, their science educational experience may not be preparing them as real and functional scientists.

The increasing number of females choosing science is another noticeable trend, possibly resulting from conscious efforts made to remove gender-stereotypes from the new curricula. However, the majority of females continue to select biology, while the physical sciences and mathematics continue to attract more males. The fact that the majority of biology teachers are females may be reinforcing this situation.

**Teachers and Teaching**

At this point, it is fair to observe that West African teachers at any grade level are working under very adverse conditions which affect their quality of teaching. In Nigeria, which has many more teachers than the other countries combined, more than 60% of all elementary school teachers in the region are unqualified to teach (Nigeria, 1986). The most qualified are mainly secondary education graduates from a five year post-elementary teacher training course. All teachers, qualified or not, are generalist teachers who teach all subjects, although most of them are unqualified (and unwilling) to teach science. Thus, science is left untaught in many classrooms. And, even when taught, many of the teachers adhere rigidly to the recommended textbook, dictating notes instead of giving students the opportunity to explore their environments as envisioned in the curriculum. The result is that students graduate from elementary school with little or no knowledge or understanding of science, let alone minimal competence in science process skills. This weak background in elementary science compounds the problems of teaching science at the secondary level.

**Teachers teach only those aspects of the subject in which they have some competence and background**

Likewise, the majority of secondary science teachers are unqualified. For example, more than 60% of all secondary school teachers (science and non-science) in Nigeria were unqualified as recently as 1984 (Nigeria, 1986) and generally science teachers are in short supply, particularly physical science and mathematics teachers. The situation for integrated science at the JS level is worse because a majority of the teachers are specialists in only one science subject (usually biology), and often do not have a broad enough science base or training in the teaching of integrated science. Most often, such teachers teach only those aspects of the subject in which they have some competence and background. The majority of junior and senior secondary science teachers nearly always employ the lecture method, and emphasise mainly the informational aspects of science. Where laboratory work is done at all, it is usually the verification type which is most often accomplished by teacher demonstration. Thus, students learn passively, mainly by rote memorisation and, due to a shortage of qualified science teachers in secondary schools, the few available are often over-worked. It is not uncommon to find a specialist in biology, for example, unqualified but teaching other science subjects, or a teacher coping with more than 30 class periods per week. Little time is available for proper planning and presentation of lessons and teachers rarely meet with each other. Elementary science teaching is equally problematic since science is not a compulsory subject in teacher training colleges.

Science teacher associations in all the countries have been very active in organising workshops aimed at updating the knowledge and skills of their members

Making science compulsory in teachers colleges is the first vital step, which must be followed by other efforts at upgrading the qualifications of teachers such as the Associate Diploma in Education (ADE) program in Nigeria. In the ADE program, experienced qualified primary school teachers (with or without some science background) spend a full year on an intensive mathematics/science education course either at a university or a college of education. Nigeria's plans to make the National Certificate in Education (a three year post-secondary program) the minimal qualification for teaching in elementary schools could also be emulated by other countries in the region.

A research-supported strategy (Yager and Penick, 1990) that may be used to improve the performance of K-12 science teachers (no matter the grade level) in the region is the constant organisation of in-service workshops. Such workshops would involve participants in analysing their needs and focus on specific teaching strategies. To encourage participants, they should enjoy benefits, such as cash stipends or earned course credits as commonly done in the US and many other countries. Such workshops in West Africa have not made the necessary impact because participation, in addition to not immediately rewarding teachers, oftentimes, requires participants bearing the cost on their own (such as in Nigeria).

Science teacher associations in all the countries have been very active in organising workshops aimed at updating the knowledge and skills of their members. If science education is to be improved systematically, these initiatives must be supported by teachers' employers directly and continuously. Similarly, pre-service teacher education needs to be re-designed to emphasise practice as it relates to theory. Student teachers need to spend more time analysing teaching/learning behaviours, comparing theory to practice, and participating in multiple practical teacher experiences, even before student teaching. This may imply a delay of certification while extending the course duration but, such is the price of increased competence and professionalism.
Assessment

An end-of-course First School Leaving Certificate Examination is conducted by respective governments in the region at the end of elementary education in Grade 6. Often, science is not part of this examination, for obvious reasons. Thus, formal assessment in K-12 science is left to the secondary school. The final secondary course examination (WASCE) in each science subject comprises a theory, a multiple-choice, and a practical paper, based on a generally over-loaded syllabus. The theory and multiple-choice papers are generally criticised for concentrating on recall and other low cognitive level items. While this has changed with time and items are now fairly well distributed among the different thinking levels, the largest number still require little more than recall. The massive scope and emphasis on recall may be partly responsible for the preponderant use of the lecture method by teachers, as a measure of success in teaching is the number of students passing the examination. Teachers hardly venture out of the examination syllabus and much time is spent rehearsing past question papers with students. This observed pattern is expected to change with the adoption of continuous assessment as an evaluation strategy in the new educational policies currently being implemented in the region.

Practical skill assessment is often the verification type and a once-and-for-all affair in the three-hour practical examination. The continuous assessment policy should positively influence teaching and assessment in this, as well as in the affective domain. The fact that continuous assessment scores are expected for each student in these domains should encourage teachers to involve students more in laboratory activities. And if practical and other examination questions begin to include more thoughtful, higher cognitive level items, teachers will follow suit in their teaching.

Conclusion

The state of K-12 science education in the English-speaking West African sub-region, particularly in terms of curriculum objectives and content, has certainly improved with time, but there is still a great need for further improvement. Both pre-and in-service teacher education need drastic improvement, especially in providing appropriate science content and more focus on teaching strategies. Similarly, the provision of teaching/learning resources and teachers' welfare both need improvement. A continuous re-appraisal of the curriculum in the light of contemporary developments world-wide would contribute greatly to a more consistent improvement in West African education. For instance, more needs to be done to encourage the teaching of science in the context of technology and society, a contemporary trend (Harrison, 1985) which is appropriate and useful in the African context.

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Science Education around the World

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Science across Europe
by John Holman

Background
As the countries of Europe move closer together, it is important to raise the awareness of European citizens for one another’s societies.

It is common experience in most countries that the most effective way of introducing new educational topics is to tie them closely to the curriculum. It is therefore proposed that an area of the curriculum that is studied in all European countries, namely science, be used as a vehicle for introducing European awareness into schools.

Aims
The project Science across Europe plans to produce curriculum materials based on European science-related issues. The aims of the project are to:

• Introduce a European dimension into science education by showing the different national traditions within a common European culture.

• Raise students’ awareness of the perspectives and ways of life of students in other European countries.

• Raise students’ awareness of the ways in which science and technology interact with society, industry and the environment.

• Provide opportunities for students to develop skills in communication in its widest sense, including languages other than their own.

• Provide opportunities for schools in different countries to collaborate.

Intended outcomes
The project will produce a series of short units (lessons) for use in conjunction with the science curriculum for 14 to 17 year olds. The units will be translated and adapted to make them appropriate to each of a range of European countries. Each unit will be based on a science-related issue, selected according to the following criteria: (1) the extent to which the issue affects students throughout Europe, and (2) the extent to which it links to mainstream science curriculum topics.

Collaborators
The project has been initiated by the Association for Science Education (ASE) in collaboration with British Petroleum (BP). ASE has close links with science teaching associations in a number of European countries, and with the International Council of Associations for Science Education (ICASE).

The pilot phase
The pilot phase began with a small writing workshop in Bruges, 15-17 June 1990. A small group from schools and universities in six European countries met to draft the first units. The countries represented were France, the Netherlands, Switzerland, Sweden, Spain and Great Britain. A general strategy was agreed upon for the project, and the first two pilot units were drafted in English. Arrangements were made for subsequent translation and adaptation of the units into French, Dutch, German, Swedish and Spanish, and for trialling them in the countries represented at the workshop, with the likelihood of additional trials in Belgium, Norway and Portugal. The following timetable has been set for the project:

<table>
<thead>
<tr>
<th>Timeframe</th>
<th>Activity</th>
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<tr>
<td>Jun-Sep 90</td>
<td>Production of the two pilot units in English</td>
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<tr>
<td>Sep-Nov 90</td>
<td>Translation and adaptation into other languages</td>
</tr>
<tr>
<td>Dec 90-Jan 91</td>
<td>Trialling of the pilot units simultaneously in the countries involved</td>
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<tr>
<td>Feb 91</td>
<td>Evaluation of the trials</td>
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Outline of the pilot unit "Europe's Energy Sources"

“This unit is a comparison of domestic energy sources used in different countries. Students will survey their own uses of energy and the costs, particularly those for cooking and heating homes, and produce data for their class. Having completed the class analysis, they make contact with students in other European countries who have undertaken a similar survey, and receive the equivalent information in return.

Students will then evaluate all the data and answers to the questions in the survey, comparing usages, prices and opinions.

This will lead to a discussion of the interdependence of countries for their energy supplies (e.g. electricity, gas); how their use of energy affects other countries (e.g. air pollution); European measures to reduce energy use; future developments in the kind of energy sources used in Europe.

Outline of the pilot unit "Acid Rain"

This unit is a survey of the acid rain problem in different countries, and a comparison of different perspectives. Students collect, by direct contact, information on the nature of the acid rain problem in different countries, the measures being taken to counter it, and people’s perspectives on where the blame lies. Students then evaluate the subjective information they have collected by comparing it with a collection of factual data for different
countries on, for example, production of sulfur dioxide, prevailing winds and average pH of rainfall. They can thus get a view of differing perspectives and evaluate them on the basis of hard fact.

A major feature of both these pilot units is the need for students to collect information by direct contact with one another. In the trial stages of the project, we will limit the number of schools to help them make contact with one another. We are encouraging contact by all means available, but particularly by fax and electronic mail.

Trials and further development

Trials will be conducted through two networks. The first is a small and closely controlled group of schools identified by those involved in the initial writing workshop.

The second network is based around BP's European operations, and we are hoping to build partnerships between individual schools and BP centres, and enable the schools to use BP's communication network.

Following the evaluation of trials, decisions will be made on future developments. Future work may include:

- Revision and improvement of the existing pilot units in the light of feedback from trials.
- Production of further units; we have had many suggestions for possible topics, particularly on themes relating to energy, the environment, food and agriculture, and medicine.
- The extension of the project to include other countries.

For further information, contact the Project Organiser:

John Holman
225 Botley Road
Ley Hill, Chesham
Buckinghamshire HP5 1XY, UK

Results of 1989/90 CASTME Awards

First Prize
Application of computers at the School for the Deaf in Cyprus by Mr Panteleimon Makris, Cyprus

This is a description of the introduction and development of computing facilities in a school for the deaf. It is a clear presentation of a careful program extending over several years.

Joint Second Prize
Use of scientific enquiry methods to teach advanced-level students science by Sujatha Gunaseeli Kankanige, Sri Lanka

A project on environmental issues aimed at developing skills. It uses a case study to introduce concepts connected with environmental pollution. The evaluation is in terms of student behaviour.

Measurement in real life by Miss Joy O’Jon and Mr Ian Blair, Guyana

A careful account of a remedial series of practical lessons with pre- and post-tests and samples of children’s work.

Joint Third Prize
Promoting scientific literacy through the publication of a student science magazine in Brunei Darussalam by Peck Yoke Oh, Brunei

This project aims to increase and spread scientific literacy through the publication of a science magazine for students. It highlights economic and social issues. The mechanics of publication are carefully considered.

Low cost heating source for use in secondary school science laboratories by Miss Cherri George and colleagues, Guyana

This team of teachers explores the use of alternative sources of energy for laboratory science experiments requiring heat. The project uses easily available materials and has a low cost implication allowing more experiments to be conducted.

A practical method of teaching mathematics through naturally available resources by Ms Bettadapur Venkatasubbiah Subhadra, India

This project uses leaves, fruits, etc to illustrate geometrical concepts thus avoiding too much abstraction in early mathematics. Examples of children’s work are included.

Commendations

An enrichment activity to encourage students to apply concepts/skills of measurement/perimeters to a recreational situation by Mr Kenneth Baisden, Trinidad & Tobago

A description of a game invented by the author to reinforce specific mathematical concepts.

A project to conserve top soil and fertility by Mr K V Rangaswamy, India

This is a project to teach students the dangers of soil erosion and ways of combating it through practical activities.

A comparative study of teaching mathematics to students of standard I by practical and non-practical teaching methods by Miss Kumudben Narmada Shanker Vyas, India

An account of a series of practical lessons in early number work, comparing their effect with that of a purely symbolic approach.

Have you entered for a CASTME Award?

The awards are intended to encourage teaching of the social aspects of science, technology and mathematics, with particular reference to developing countries of the Commonwealth. Teachers and officials (advisors, inspectors, etc) working in primary, secondary and tertiary education in Commonwealth countries are eligible to enter as individuals or syndicates.

Registration Forms (to be received by 30 November each year) are available from your local British Council office or Education and Science Division, The British Council, 10 Spring Gardens, London SW1A 2BN, UK
The LMKF Conference 1990 was the 14th in the series of triennial Nordic meetings, and the first to be held in Iceland. There were more than 300 participants including delegations of approximately 100 from Finland, 100 from Sweden, and smaller numbers from Denmark, Norway, Iceland and the Faroes. Professor M Rubinstein, a specially invited speaker from the USA, and Dennis Chisman, representing ICASE and Unesco INISTE, also attended the Conference.

Main sessions comprised concurrent lectures, symposia, discussions and workshops. Most lectures were presented in various Scandinavian languages; a few were presented in English. Lecture and symposia topics were wide ranging, and included computer interfacing and modular programming; women in science and engineering; plate tectonics and earthquakes; and marine science.

Workshops and discussion sessions focused on the teaching of mathematics, physics and chemistry.

During the Conference, a special meeting was held to discuss the establishment of an Icelandic branch of INISTE. This meeting was convened by Halfor Gudjonsson who was the Icelandic representative at the 2nd Nordic Science Education meeting held in Finland, under Unesco INISTE auspices, in August 1989.

It was agreed to set up an INISTE, comprising representatives of the various national science education organisations in Iceland, including LMKF.

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**Twin Teacher Trainer Project**

The Science Education Section of the Unesco Division of Science, Technical & Environmental Education is concerned with the problems in some teacher training institutions caused by their isolation due to geographical location, political barriers or lack of resources.

In many countries, cities or towns are paired with similar cities or towns in other countries in order to form twin cities or twin towns which exchange information of mutual interest and exchange visits.

Perhaps twin teacher training institutions could exchange handbooks, course materials, examples of trainee's work, photographs and new ideas to their mutual benefit.

The Science Education Division could identify isolated institutions in another country, provided that both institutions agree.

Unesco would not be in a position to provide funds to facilitate these exchanges, however the resources of Unesco could be used to assist in the contacting of isolated institutions.

Some institutions have already been contacted, and many positive responses have been received.

The Science Education Section would like to obtain from each country, address lists of teacher training institutions. These may already be compiled on a database or in a publication.

For further information, write to:

**John Elfick**
Program Specialist
Science Education Section
Division of Science, Technical & Environmental Education
Unesco, 7 place de Fontenoy
75700 Paris
France
GHS Science Fair in Cameroon
by Augustine Kiteh
Government High School

In 1987 science teachers in Government High School, Nkambe decided to organise Cameroon's first science fair. The aim of this event was to encourage students to display their knowledge and skills in science, to enable students to see that science can be fun, and to entertain the largely illiterate public by staging a number of science demonstrations.

The science fair was conducted during 'Youth Week' so as to involve neighbouring schools, the local administration and the general public.

In order to gain maximum publicity, the teachers invited government administration officers, political party leaders, church dignitaries, primary school headteachers, school proprietors, and other local prominent people. These individuals were requested to donate a small prize for the display competition.

Since 1987, this practice has continued at GHS Nkambe, one of several schools in the North West Province of Cameroon. Science teachers at GHS Nkambe are keen to involve all schools in the province, and see this as an effective strategy toward "Science for All" in Cameroon. They would welcome suggestions on how to improve the science fair.

The education system in Cameroon tends to be preoccupied with two curriculum-related problems: The first involves the need to update, strengthen, and increase teacher effectiveness, especially in the areas of maths and science. The second and much more difficult problem, inherent in any mass educational system, is the need to adapt curriculum and teaching methods to cater for a diversified student body - slow and fast learners, less and more academically motivated students, a wide spectrum of interests and career aspirations among students, terminal students and college-bound students and the 'undecideds'.

Augustine Kiteh teaches at Government High School, Nkambe, NW Province, Cameroon.

International Symposium on Fieldwork
22-28 April 1990
by Jan Hendriks & Henk Lindeman

SISFIS (Foundation International Symposium on Fieldwork in the Sciences) was founded on the initiative of NVON (Dutch Association for Teachers in Science Education) in 1988, and undertook the planning and organisation of an International Symposium on Fieldwork in the Sciences.

For practical reasons it was decided to organise an International Symposium and a National Conference.

The International Symposium, held at Westerbork in the Dutch province of Drenthe during 22-27 April 1990, was coordinated by SLO, the National Institute for Curriculum Development. 51 participants from 16 countries attended the International Symposium chaired by Jacques van Trommel, the advisor for curriculum development in the Netherlands and secretary/treasurer of IOSTE.

The program included lectures on world trends in fieldwork, computers and field work, and implementing field work programs; discussion sessions; fieldwork sessions using programs developed by participants; and excursions to the National Park 'De Wierribben' and to Kampen.

Many lively discussions were shared, and it became obvious that there is a need for more meetings of this kind. There were distinct resemblances, as well as distinct differences in trends and approaches.

Participants focused more on the development of fieldwork, rather than its implementation. Strategies for involving whole classes in fieldwork are still poorly developed at the international level.

The National Conference, also held at Westerbork during 27-28 April 1990, was coordinated by the Orvelte Field Study Centre to coincide with the annual conference organised by NVON. The major purpose of this Conference was to offer secondary school teachers knowledge, understanding and experiences of fieldwork to encourage them to incorporate fieldwork in their teaching.

Nearly 300 teachers of geography, biology, physics, chemistry and integrated science took part in the National Conference. The varied program included lectures on fieldwork and many practical fieldwork assignments, many of which incorporated aspects of physics and chemistry. The National Conference was also very productive for participants, who completed practical experiences in fieldwork - an important prerequisite before involving students in fieldwork.

The organisers are grateful for the subsidies and assistance provided by the Dutch Ministry of Agriculture, Conservation and Fisheries, the National Institute for Curriculum Development, the Advisory Body for the Development of Curricula in the Sciences, the Dutch Province of Drenthe, the Dutch Petroleum Company, the Shell Oil Company, NVON, the Royal Dutch Geographical Society, the Dutch Society of Chemical Industry, and the World Wide Fund for Nature.

Photo: Drs Jan Hendriks, ICASE European Representative and Treasurer of SISFIS
First International History Philosophy and Science Teaching Conference

A Report

The first conference of the International HPS and Science Teaching Group was held at Florida State University from 5-10 November 1989. It was attended by nearly 300 people from 20 different countries. It was generously supported by the American National Science Foundation.

A feature of the conference was that many of the 125 papers delivered were available beforehand so that nearly each session was a working session with maximum time for comment and deliberation. Four journals ran, and overprinted, special issues on the conference theme; these contained 40 papers and were available prior to the conference. Additionally papers were asked to be submitted on disk, and an attractive book of 37 of these was also published prior to the conference. Two post-conference journals are being published, as well as a second volume of Proceedings.

Many remarked that this pre-conference publication format could be profitably followed by other academic organisations.

There were 2-3 Plenary Sessions each day, and 3-4 concurrent sessions. Topics discussed included: rationality and science, science and moral education, history and philosophy in physics teaching, history in chemistry teaching, feminism and science, the textbook image of science, constructivism, HPS in science teacher preparation, science literacy, and many others.

Many examples of the successful implementation of HPS informed lessons, and curricula were provided. It was acknowledged that these need to be further developed, and that some mechanism needs to be provided so that scholars and teachers in different countries and different disciplines are not re-inventing the wheel. Much is being done, but it needs to be publicised. Fabio Bevilacqua of Pavia University spoke of the longstanding efforts of the European Physical Society to promote history of physics in physics teaching, and expressed the hope that greater contact could be arranged between the two groups.

It was agreed that conferences would be held on 3-4 yearly intervals.

Second International History Philosophy and Science Teaching Conference

The dates and venue for the Second International Conference on History, Philosophy and Science Teaching have now been finalised. It will occur at Queen's University, Kingston, Ontario, Canada, 11-15 May 1992.

The title and a 200 word synopsis of papers should be submitted by 12 October 1991. On receipt of this, full style guidelines and format advice will be sent. Papers should be between 4000-6000 words, and submitted on disk along with 3 copies by 12 January 1992. All conference papers will be printed in Proceedings that will be published in advance of the conference.

Further details are available from the Conference Secretary:
Prof Skip Hills
Faculty of Education
Queen's University
Kingston
Ontario
Canada K7L 3N6

Newsletter

A newsletter is being produced for scholars worldwide who have an interest in the use of history and philosophy of science to improve science teaching and research. For details of subscriptions, write to:
Dr Michael R Matthews, Editor
School of Education
University of New South Wales
Kensington NSW 2033
Australia

SciLINC Project

Launched to Improve K-12 Science Education

by Kenneth Russell Roy
ICASE North American Representative

The Science Leadership Institute Network Centers Project or SciLINC has been initiated this fall in the United States according to the NSSA's LISE Center Executive Director Dr Ken Roy. He noted that there is a high level of excitement about the potential of this project in that it establishes a national network of district level science centers committed to improving science education through leadership development training and resources. With a variety of reform movements to improve science education in the states, there needs to be a vehicle for bringing about change at the local level. This initiative serves to meet that need. The NSSA's LISE Center has developed this long term leadership training program to improve science education as a grass roots level initiative. SciLINC districts will specialise in elementary and/or secondary science.

How SciLINC works

Operationally, the LISE Center trains a cadre of regional and state directors. Each director then provides training through state leadership institutes for local SciLINC District supervisors. Programs are effected with support from locally developed business/education alliances. Once trained, local supervisors/teacher advocates serve as SciLINC District directors for their school or district's network center. Each level of training
is upgraded on an annual basis to keep
the director's skills sharp and
knowledge base current to improve
science education at the local level.

First training program

The first training program for new
state directors was conducted for three
days during September 1990. Seminar
topics focused on several areas
including supervisors/teacher advocates
as change agents, effecting long term
change, changing needs of students,
leading edge curricula reforms and
general issues and initiatives.

Implementation time line

Phase I (1990-91). During 1990-91,
State Network Center directors will be
selected and receive training in two
NSSA geographic regions or
approximately 17 states. Later in the
academic year, SciLINC Districts will
be selected and center directors will
receive training in each state.

Phase II (1991-93). During 1991-93,
the balance of the NSSA regions or 33
states will be introduced to SciLINC.

For more information, write to: Dr
Kenneth Russell Roy, Executive
Director, NSSA LISE Center,
Copernicus Hall, Suite 227-228,
Central Connecticut State University,
New Britain, CT 06050, USA

Australian Science Education Research Association

Report on 21st Annual Conference
Perth, Australia, 14-17 July 1990

by Dr David Tregast
Curtin University of Technology

Held on what turned out to be the
wettest weekend of the year, the 90
science educators who attended
ASERA 1990 could not be
convinced that Perth is the sunniest
capital in Australia. This was the
first time ASERA had been held in a
hotel and especially given the
inclement weather, this proved to be
an ideal location for the conference.

The 90 conference attended 54
sessions addressing a range of topics
in primary, secondary and tertiary
education. Sessions involved
empirical studies, descriptions of
research programs and discussion
papers. Topics included technology
education, computer education
related to science teaching,
evaluation of new and longstanding
curricula, methodological issues for
improving science education and
investigations into student learning.

Conferences attended from all states
and territories in Australia with a
small number of science educators
coming from Malaysia, the USA,
New Zealand, Papua New Guinea,
Israel and South Korea. There was
ample opportunity in the program
schedule for informal discussions
and science educators were engaged
in interesting debates throughout
the conference.

Next ASERA conference

Next year's conference will be held
in Brisbane in July 1991. For
further details, contact:
Dr Cam McRobbie
Kelvin Grove Campus
Queensland University of
Technology
Locked Bag No 2
Red Hill Qld 4059
Australia

CSIRO Women in Science Project

Australia's Commonwealth Scientific
Industrial Research Organisation
(CSIRO) has set up a project where
women, working in scientific research
and technical areas in CSIRO, are
visiting high schools to talk with
15-16 year-old girls.

By providing role models and
information on science careers, CSIRO
hopes to increase the participation of
girls in science and mathematics at
senior secondary level. This will
promote scientific literacy in the
community as a whole and will permit
more women to take an informed part
in current debates on issues such as
in-vitro fertilisation, nuclear power and
genetic engineering. In today's society
people also require technical
understanding for many other aspects
of life, as consumers of modern goods
and services.

Increased participation by girls in these
subjects also means expanded career
options. Many occupations, not just in
science, require a solid grounding in
science and mathematics. By dropping
these subjects at Year 10, girls restrict
the number of jobs for which they can
apply.

Australia needs talented and skilful
people to undertake research for
continued development. At present,
many able girls who could contribute
significantly in Science are not aiming
to fill these positions.

This project is a logical extension of
CSIRO's commitment to education
such as the Science Education Centres
around Australia.

Outline of the scheme

1. Interested schools are sent a
videotape entitled Women in Science
and a student activity sheet for use
with year 10 classes (both boys and
girls). The video consists of interviews
with seven women scientists about
their work and experiences as women
in the scientific field.

2. Approximately a week after the
video is shown, women scientists visit
the school to talk with Year 10 girls in
groups of less than 15 girls. Ideally a
professional scientist and a technician
each speak to the group in order to
demonstrate a range of possible careers
in science.

After a five minute introduction from
each woman on their day to day work
and how they entered their career, a
discussion is encouraged to cover
topics of interest to students.

The project has been operating for five
years, and has received positive
responses from the thousands of
students who have participated.
Field Work in Secondary Science

by Tom Schnoebele

The most effective learning takes place when connected to direct experiences (McNamara & Fowler, 1975; and others). Science outside the classroom, through the use of field trips, is an excellent way to accomplish this. Science students need to be reminded that the world itself is the real laboratory.

"Classroom experiences seldom carry the student beyond chalkboard living, and a chalkboard interpretation has only a superficial resemblance to reality. Laboratory activities may - but not always - come closer in a flyby to more complete understandings. For the learning of many important concepts, however, students can't become involved in direct experiences when confined in the classroom. Therefore, for these concepts it is important, whenever possible, to get students out of the classroom and into contact with the real thing." (Lisonbee 1986)

A rationale for field work

Many authors have described the benefits of field trips for teaching science at the secondary level. McNamara and Fowler (1975) studied 1200 junior high earth science students, one-half with laboratory investigations in an outdoor environment using pre-packaged materials and the other half with laboratory investigations in the outdoor environment using available natural resources. They concluded:

1. Concepts that are an integral part of the students' environment are best learned in the outdoor environment.

2. If parts of a concept can be related to the students' immediate environment, the concept has a better chance of being understood, whether the concept is concrete or abstract.

3. Critical thinking is enhanced in the outdoor environment, especially for the average to below-average student.

4. Investigations in the outdoor environment increase the students' desire for that environment.

5. Lower ability students tend to prefer the environment to which they are exposed.

Sorrentino and Bell (1970) reviewed articles presenting the values attributed to secondary school science field trips. They compared attributed values with empirically determined values and determined that field trips were beneficial in the teaching of secondary science. Mason (1980a) annotated 43 studies related to the use of field trips in elementary, secondary, and post-secondary education spanning a period from 1930-1977. His analysis shows field trips are an effective instructional technique as well as an important link between the classroom and the outside world.

Research suggests a positive link between field trips and knowledge gains (Benz, 1962). Riban and Koval (1971) reported that students who participated in extended field studies were found to gain significantly in use of scientific methodology. Motivational gains (Ignatius, 1978; Kern & Carpenter, 1984) have also been documented in the literature.

Harvey (1951) studied the effect of the field trip upon the development of scientific attitudes. Selecting two sections of ninth grade general science classes for the experiment and conservation as the unit of study, he concluded that students who participated in field trips had significantly more positive attitudes toward science than students who remained in regular classrooms.

Barriers

Unfortunately, teachers do not take advantage of field work. For instance, Keown (1986) surveyed the use of outdoor resources in the teaching of natural science in secondary schools and found that 16 percent of classes do not study science outdoors and the majority of classes use outdoor resources fewer than three times during the school year.

Results from several studies have identified certain problems or barriers that cause teachers to avoid using field trips. Muse and Davidman (1982) surveyed 300 elementary and secondary teachers and asked them what problems seemed to be most bothersome about field trips. Elementary teachers were concerned with costs associated with field trips, while secondary teachers listed students as a problem area. Three teachers specifically stated that "junior high kids are too squirelly to take on a field trip!" Thus, the issue of controlling student behaviour appeared to weigh more heavily on secondary teachers' minds than it does on elementary teachers'. Keown (1986) found that teachers rated financing travel and large class size as the main impediments to outdoor natural science. He added, however, that many teachers named class schedules and
time allotment for field trips as well. Mason (1980b) published results of a study that examined the status of field work in Virginia. He surveyed all full-time earth science teachers during the fall of 1975. The main hindrances perceived by teachers were: (1) lack of planning time; (2) lack of resource people for assistance; (3) failure of the school to assume trip risk; (4) lack of a satisfactory method of covering classes; (5) restrictions placed on field work by school regulations; (6) lack of administrative leadership, support and encouragement; (7) lack of funding; (8) limited available transportation; (9) too much "red tape"; and (10) excessive class size.

McKenzie and Lisowski (1986) point out that science teachers educated in lab-oriented sciences, with limited field experiences, are frequently unfamiliar with the organisation of field trips and therefore tend to avoid them.

Ideas to encourage effective field work

1. Communicate your rationale

If science teachers are going to use field trips in their curriculum, they must be prepared to explain why they are important. What are the educational values in field trips? How do they fit in with your classroom goals?

Questions such as these can be answered by preparing a rationale statement that substantiates the benefit of using field trips. Teachers should include supporting research in this rationale, and be able to communicate it to students, parents, fellow teachers, and the principal.

In addition, when planning a field trip, explain what the objectives are and why the trip is necessary. Researchers Muse and Davidman (1982) recommend that, if teachers are to make field trips more educative and effective in terms of learning outcomes, then field trips should provide unique outcomes that cannot be attained in the classroom setting or through the use of simulations of media such as film strips, slides, or movies. They suggest that dependence on field trips as a mere diversion or break from classroom instruction will probably not yield significant improvement in attainment of cognitive or affective outcomes. Thus, the rationale for a field trip, at minimum, should specify how the trip will benefit students in a way not possible in the classroom and how the trip fits into the curriculum.

2. Be informed

How can a science teacher with little experience in the use and organisation of field trips begin? The best answer is that they have to become aware and informed of available resources. Troy and Schwab (1981) offer recommendations to teachers who engage in field trips:

1. Be familiar with existing state laws and school district policies regarding field trip procedures.

2. Plan in advance. The ability to demonstrate that reasonable and cautious plans were made will be of immeasurable assistance in defending against any liability action.

3. Obtain approval for the field trip and authorisation for transportation from school officials. Do not use private vehicles. Be sure that proper insurance cover is effective.

4. Contact the authorities of the site to be visited and secure their permission to make the trip.

5. Provide parents with specific information about the trip and require written consent for the child to participate.

6. Visit the site prior to the trip and check for potential hazards.

7. Check out a first aid kit which has been inspected and approved by the school nurse. Review first aid procedures needed for the type of

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**ICASE AWARD SCHEME**

*for outstanding contributions to international science education*

**ICASE Distinguished Service Award**

This award is made to individuals who have a career history of distinguished service to international science education through their involvement in the international activities of local, regional and global science education organisations

**ICASE Regional Service Award**

This award honours individuals who have made a significant contribution to international science education through their involvement in international activities at the local and regional levels

**ICASE Association Award**

This award recognises individuals who, within their science teacher association, have made a significant contribution to the international activity of their association

Contact Dr Jack Holbrook, Executive Secretary ICASE

Department of Curriculum Studies, University of Hong Kong, Hong Kong
accident which may occur.

8. Identify emergency procedures for treatment and reporting of accidents. Report any injuries which occur to proper school authorities.

9. Provide students with special safety equipment which may be appropriate for the planned activities. Be sure that the equipment is in proper working order.

10. Provide adequate supervision. At least one adult for every ten students is recommended.

Many journal articles and books describe effective field trips. Workshops or in-service courses offer practical teaching methods. Colleges and universities usually provide these workshops, but that should not stop a group of teachers from starting their own workshop. Teachers can share their experiences and ideas. They may want to compile a list of essential field trips and work out the details of each (that is, a list of potential hazards and safeguards, estimated costs, suggested ratio of chaperones to students, educational value to students at the designated grade level, and suggestions on how to integrate the trips with curriculum, both before and afterwards).

There are also many local services available to teachers that are free or very inexpensive. For instance, each state has a geological survey that often provides assistance in the location and proper use of suitable field trips.

Field trips are an excellent way to get people in the community involved and to improve relations between teacher, parents and students. Perhaps one of your students has a parent who is a professional conservationist. The teacher can get advice on how students can plant trees around their school and study them, or how to get students to do a survey of the school's soil. This person could also involve students in a field trip or at least be able to give the teacher some useful literature.

University students may be available to help out on field trips as well. They could work with the teacher to plan an effective team teaching experience outside of the classroom. None of these things will happen, of course, unless the teacher takes the initiative to become informed.

3. Start a field trip file

Science teachers can collect meaningful activities and information concerning field trips in a file. For each activity, the teacher should write personal notes concerning the purpose, timing and planning of the trip.

An organised field trip file will save time and headaches in the planning of field trips. Muse and Davidman (1982) suggest that field trips be preceded by a series of activities/experiences that will serve as advance organisers and focus student observations during the trip. The field trip file would be an excellent place to include these advance organisers, as well as post-trip activities.

After taking a field trip, evaluate the trip in terms of strengths and weaknesses. Make a note to repeat the worthwhile activities and indicate ideas for changing the situations which did not work. Again, all this can be saved and put into the field trip file for future use.

4. Begin with simple, inexpensive field trips

Nothing implies that field trips have to be expensive and time consuming. In fact, Harvey (1951) demonstrated that a worthwhile excursion can be conducted within a 55 minute class period. Teachers should begin with simple, inexpensive field trips close to school and work their way towards extended field trips. Also with these simple field trips, the students could more easily set the objectives, be involved in the planning, and evaluate the strengths and weaknesses. This would of course take some of the planning duties away from the teacher and allow for time to do other things.

Fitzsimmons (1983) says each school building and its grounds offer their own set of on-site field trips waiting to be discovered and used. He describes five successful field trip activities that have been used successfully with eighth grade earth science classes. These on-site field trips cost nothing, were completed in a single class period, and presented no scheduling problems. He also added that with field trips such as these, students become involved in the subject and are less likely to misbehave.

Eventually a teacher can begin implementing more complex field trips. Riban (1971) describes a program where the field trip is used not just for instruction, but for investigation. The problems to be investigated are initiated and defined by students during a four-day period.

5. Be positive

As a final suggestion, teachers should be positive and not become discouraged or be afraid of failure in taking a field trip. The field trip can pose teaching and learning challenges to the teacher, but with creative teaching, it can be a valuable source to help students understand how science relates to their everyday life. Sharp (1952) has this to say about teaching beyond the classroom walls.
"In the outdoor classroom the student stands beside the teacher; they are facing in the same direction, looking toward the object that is under observation, they are partners in learning . . . and . . . when they go back into the indoor classroom . . . much of the stiffnessthathas gone out of the educational process, to be replaced by a new kind of eagerness never before seen within these walls."

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About the Author

A native of Iowa, Tom Schnoebelen will receive his B.S. (Honours) in Science Education in May 1991. He plans to teach chemistry and physics in a secondary school.

Who’s Who in Science Education Around the World

1991 Edition

This valuable reference book will contain brief profiles on prominent science educators and their work. Advance copies (E6 or US$10 or A$13) can be ordered from the Editor 10 Hawkens Street, Monash ACT 2904, Australia Cheques payable to "ICASE"

An ICASE Initiative
The Children & Youth Science Centre
China Association for Science & Technology

The China Association for Science & Technology (CAST) is a large organisation of scientists, engineers and technologists, and a federation of both the national natural science societies and local science & technology associations. In an era of rapid development of science and technology, CAST has been active in the task of improving the quality of science education for children and young people.

Following the setting up of the Department of Children and Youth Affairs in 1978, the Children and Youth Science Centre - a national institution for children's education - was formed. With the support of many national science societies, the Centre promotes a wide range of scientific activities for children.

Through practical work and experiments, children acquaint themselves with new scientific knowledge, stimulate their interest, expand their abilities to work independently, and foster their ideals. The CAST Children and Youth Science Centre liaises with other Children and Youth Science Centres in provinces and municipalities which are administered by the Central Government, and has formed a network for children's science education.

The many activities which have been jointly sponsored by the CAST Centre, government departments and other organisations, include exhibitions of science projects, creative invention contests, science seminars, camps and tours, contests relating to the natural science subjects, in-school and out-of-school scientific hobby groups, "Love Science Month", and science experiments in rural areas.

Hobby group activities have been carried out in many middle and primary schools in urban and rural areas throughout the country. Activities have ranged from monitoring city environments to farm planting and cultivation experiments, from constructing radios or models to computer programming, and from tests in physics and chemistry to astronomical observations.

Camps in science and technology are held during vacation periods, and enable hundreds of thousands of children to enjoy their holidays in the mountains or at the seaside, to broaden their knowledge and appreciation of their country's environment.

A national creative invention contest and science seminar is held every two years. Since 1982, more than 600 creative inventions and 300 seminar papers have been produced.

Thousands of children and youth take part in mathematics, physics, chemistry, computer and other contests each year. Those middle school students who win national contests travel to international olympiad competitions in mathematics, physics, chemistry, etc.

CAST also focuses attention on children's science activities in minority nationality regions, remote areas and rural areas. Several local Children and Youth Science Centres make use of mobile buses equipped with science exhibits, popular science lecture materials, scientific films, videos and books. Ten million children benefit from such programs each year.

The Children and Youth Science Centre of CAST liaises with the United Nations Children's Fund, Unesco, and several science education institutions in other countries and regions, and is keen to establish contact and an exchange of information with colleagues in other countries.
The John Gardiner Centre, which came into operation just over a year ago, provides a range of science, mathematics and technology activities for students, teachers and the community. In the first year:

- Over 1000 teachers have become members of the Centre and have been involved in professional development activities run by the Centre.
- The Centre has developed a wide-ranging program of activities, including teacher professional development courses focusing on 'hands on' science for primary teachers; science and technology 'hands on' classes for over 8000 primary children; and science and technology holiday programs for hundreds of primary children.

- The Saturday Afternoon Science for Families program, launched in April 1990 and held on the first Saturday of each month, has been extremely popular.

The aim of the activities is to provide students with opportunities to experience science 'hands on', and at the same time, to provide teachers with the confidence and experience to teach more science in their own classrooms. During the past year, the following activities have been available for primary students.

**Light and Colour (Grades P-6)**

This activity includes: filters, lenses and prisms; pigments and dyes; lighting in houses; photography; ultraviolet light and the skin.

**Electricity (Grades 3-6)**

Students construct electric circuits to switch on lights, ring alarm bells, work motors and household appliances; they determine what is in an electric puzzle box; they play a simulation game in which they are 'volt people' and 'electron people'; and they tinker with electric appliances to see how they work.

**Balancing Acts (Grades 4-6)**

Students examine the principles of balance and centre of gravity as they perform simple balancing acts, construct balancing toys and mobiles, and look at the science of high jumping, long jumping and tightrope walking.

**Flight (Grades 3-6)**

In this activity, students design and construct helicopters, unusual planes and gas-propelled rockets, as they learn the basic elements of aerodynamics.

**Metals and Magnets (Grades P-6)**

Students make magnets and electroplate coins; they look at some of the ways we use metals and magnets such as in household appliances, motors, buildings and sculpture.

**Supermarket Science (Grades 3-6)**

Using products which are easily available at the local supermarket, students experiment to analyse a number of white powders and determine what substances are in their 'mystery powder'.

**Bubbleology (Grades 3-6)**

Students investigate the intriguing nature of soap bubbles, how to use colour to predict when a soap bubble will pop, making square bubbles, and making bubbles in bubbles.

**Cabbages & Chemistry (3-6)**

The idea that chemistry only occurs in laboratories is dispelled as students use the chemicals in plants to conduct tests on soda water, aspirin and soap. They make a colourful array of solutions and discover which common household products are acids and which are bases.

**Budding Builders (Grades 3-6)**

Students test a range of shapes used in building, construct and testalsa roof trusses, and design and build simple structures such as bridges, towers and domes.

**Balloons under Pressure (3-6)**

Children complete a wide range of activities using balloons, as an introduction to the science of air and air pressure.

For further information about the Centre and its programs, contact:

*The John Gardiner Centre*
*Tooronga Rd*
*Hawthorn East Vic 3123, Australia*
STS as a Development in Science Education

by Robert E Yager
University of Iowa

Science Technology Society (STS) has become a major movement in science education in the US since it emerged as one of the five focal points for Norris Harms' Project Synthesis (Harms, 1977). E Joseph Piel headed the STS task force for Project Synthesis where exemplary STS programs were envisioned as those with the following characteristics:

- Prepare individuals to use science for improving their own lives and for coping with an increasingly technological world;
- Prepare students to deal responsibly with technology - society issues;
- Identify a body of fundamental knowledge which students may need to master in order to deal intelligently with STS issues;
- Provide students an accurate picture of the requirements and opportunities involved in the multitude of careers available in the STS area.

After the Project Synthesis report in 1981 (Harms & Yager, 1981) NSTA initiated its Search for Excellence in Science Education (SESE) Program. STS was included as one of the initial search areas in 1982-83; STS criteria were updated and a second search for STS exemplars was undertaken in 1986. Since these beginning efforts, STS has flourished as a focus for school science, as an area for identifying new goals, new curriculum modules, new instructional strategies, and new forms for evaluation. STS has been a major focus for science education reform in Iowa since the initiation of the NSTA-NSF Chautauqua Program in 1984. Today over 1000 teachers have developed and introduced STS modules into their science classrooms, especially those in grades four through nine.

STS programs have developed in ways quite different from the early ones identified in the first NSTA Search for Excellence (Penick & Meinhard-Pellens, 1984). The following table permits a twelve point contrast between standard science programs (as revealed by the NSF state studies and Project Synthesis) and the situation found in STS experiments in Iowa.

<table>
<thead>
<tr>
<th>Standard Science Programs</th>
<th>S/T/S Programs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Survey of major concepts found in standard textbooks</td>
<td>1. Identification of problems with local interest and impact</td>
</tr>
<tr>
<td>2. Use of laboratories and activities suggested in textbook and accompanying manual</td>
<td>2. Use of local resources (human and material) to locate information that can be used in problem resolution</td>
</tr>
<tr>
<td>3. Passive involvement of students assimilating information provided by teacher and textbook</td>
<td>3. Active involvement of students in seeking information that can be used</td>
</tr>
<tr>
<td>4. Science being contained in the science classroom for a series of periods over the school year</td>
<td>4. Science teaching going beyond a given series of class sessions, a given meeting room, or a given educational structure</td>
</tr>
<tr>
<td>5. A focus on information proclaimed important for students to master</td>
<td>5. A focus upon personal impact, perhaps starting with student curiosity and concern, not merely hoping to get to that level</td>
</tr>
<tr>
<td>6. A view that science is the information included and explained in textbooks and teacher lectures</td>
<td>6. A view that science content is not something that merely exists for student mastery, simply because it is recorded in print</td>
</tr>
<tr>
<td>Standard Science Programs (continued)</td>
<td>S/T/S Programs (continued)</td>
</tr>
<tr>
<td>-------------------------------------</td>
<td>----------------------------</td>
</tr>
<tr>
<td>7. Practice of basic process skills, but little attention to them in terms of evaluation</td>
<td>7. A de-emphasis upon process skills, just because they represent glamorised skills of practicing scientists</td>
</tr>
<tr>
<td>8. No attention to career awareness, other than an occasional reference to a scientist (most were deceased) and his/her discoveries</td>
<td>8. A focus upon career awareness, especially careers that students might expect to pursue as they relate to science and technology and not merely those related to scientific research, medicine, and engineering</td>
</tr>
<tr>
<td>9. Students concentrating on problems provided by teachers and text</td>
<td>9. Students performing in citizenship roles as they attempt to resolve issues they have identified</td>
</tr>
<tr>
<td>10. Science occurring only in the science classroom as a part of the school’s science department</td>
<td>10. Science study being visible in a given institution and in a specific community</td>
</tr>
<tr>
<td>11. Science being a study of information where teachers discern the degree students acquire it</td>
<td>11. Science being an experience students are encouraged to have</td>
</tr>
<tr>
<td>12. Science focusing upon current explanations and understandings; little or no concern for the use of information beyond the classroom and performance on tests</td>
<td>12. Science with a focus upon the future and what it may be like</td>
</tr>
</tbody>
</table>

Students are also found to be different as a result of major experiences with STS. Assessment has centred in five domains that are important in science teaching. Figure 1 is an attempt to depict the domains and to define STS in connection with them.

In regular science teaching nearly all attention is directed to the acquisition of information. (It probably should not be called knowledge very often since so few students can ever demonstrate that they can use the information that is seemingly learned.) It is common for school curricula and for teachers to embrace the importance of considering science processes. Nonetheless, there is little evidence that traditional science teaching is effective in helping students develop such skills, at least in a manner that they can be used in other situations in addition to the ones used to illustrate them in the classroom.

Positive student attitude and certain aspects of creativity are seen as necessary attributes for STS students, perhaps all students able to attain knowledge (useful information) and science skills/processes (useful in non-class settings). Positive attitudes and personal creativity are traits more easily attainable by dealing with issues in today’s society and technology which affect the lives of all. In traditional science courses, technology is often seen as irrelevant. (It was purposefully omitted from the pure science programs developed during the 1960s). And, current societal issues and topics that are readily related to responding to student needs and concerns are dismissed as health, psychology, or some other social study.

STS programs are defined as those starting with real world issues and concerns. Hopefully these are (or can become) student issues and not some other kind of information teachers wish to present to students.

When teachers begin with a topic from the existing course outline, a favourite topic or science concept, or information that they have been wanting to share with students, problems are often encountered. When STS is viewed as the same science concepts as those appearing in the textbooks, but with technological and societal dimensions “added on” in that order, the experience proves less successful.

Many teachers begin with frustration. What will their STS modules be? How should the task be approached? The most effective STS efforts have arisen from sharing the frustration with the students, including the choice of problem, the need for a student-based effort, the need to use applications immediately in daily living. The best STS efforts are those where the student chooses the problem to be investigated. The problem comes from unusual circumstances. Some of the best have been students who have reported problems with toilets plugging at home, a faucet which does not turn off at school, a power failure in a school with no windows, a problem with a polluted water well, and hundreds of other problems identified by students.

One of the greatest problems with school science seems to be the belief that there is essential information found in curriculum guides and textbooks which teachers must force students to go over. When real problems are internalised and the students are encouraged to work on their resolution, the power of information is soon realised. Students search out information and use it; and in the process new problems are
defined. STS means dynamic teaching and learning. Effective science classrooms cannot be passive ones where students merely go over information, information that will be used for examinations and/or activities that will verify its accuracy. In traditional science classrooms students are expected to remember, to get "the answer" on quizzes, and to make "correct" observations in the laboratory. Rarely is a real-life context provided.

STS means focusing on problems, on questions, on unknowns. It means searching for answers and explanations. However, this searching means that students encounter numerous new questions and problems. Sciencing is a never-ending process.

The best STS modules (and teacher experiences with STS) always result in teacher comments such as: "My STS module is not complete yet..."; "I just had to stop..."; "I never imagined that we would investigate so many questions..."; "I had no idea that STS would result in so much student initiative, enthusiasm, action..."; "The students did the work. They identified problems, proposed actions - they wouldn't let it stop!"

The place to begin new STS modules needs to reside with the students. They must see and buy into a problem. Real science learning cannot result from teachers "presenting" information or "announcing" the STS module. Students must have a hand in constructing the problem and determining their actions concerning it.

Students who experience science as STS are different from students who complete a traditional science program organised around the typical concepts found in most textbooks. A look at differences in each domain illustrated in Figure 1 may be helpful.

<table>
<thead>
<tr>
<th>Traditional Connections &amp; Applications</th>
<th>STS</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Students see no value and/or use of their science study to their living</td>
<td>1. Students can relate their science study to their daily living</td>
<td></td>
</tr>
<tr>
<td>2. Students see no value in their science study for resolving current societal problems</td>
<td>2. Students become involved in resolving social issues; they see the relativity of science study to fulfilling citizenship responsibilities</td>
<td></td>
</tr>
<tr>
<td>3. Students can recite information and concepts studied</td>
<td>3. Students seek out information and use it</td>
<td></td>
</tr>
<tr>
<td>4. Students cannot relate the science they study to any current technology</td>
<td>4. Students are engrossed in current technological developments and use them to see the importance and relevance of science concepts</td>
<td></td>
</tr>
</tbody>
</table>

**Creativity**

<table>
<thead>
<tr>
<th>Traditional</th>
<th>STS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Students decline in their ability to question; the questions they do raise are often ignored because they do not fit into the course outline</td>
<td>1. Students ask more questions; such questions are used to develop STS activities and materials</td>
</tr>
<tr>
<td>2. Students rarely ask unique questions</td>
<td>2. Students frequently ask unique questions that excite their own interests, that of other students, and that of the teacher</td>
</tr>
<tr>
<td>3. Students are ineffective in identifying possible causes and possible effects in specific situations</td>
<td>3. Students are skilled in suggesting possible causes and effects of certain observations and actions</td>
</tr>
<tr>
<td>4. Students have few original ideas</td>
<td>4. Students seem to effervesce with ideas</td>
</tr>
</tbody>
</table>

**Attitude**

<table>
<thead>
<tr>
<th>Traditional</th>
<th>STS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Student interest declines at a particular grade level and across grade levels</td>
<td>1. Student interest increases in specific courses and from grade to grade</td>
</tr>
<tr>
<td>2. Science seems to decrease curiosity</td>
<td>2. Students become more curious about their world</td>
</tr>
</tbody>
</table>
3. Students see teacher as a purveyor of information

4. Students see science as information to learn

3. Students see teacher as a facilitator/guide

4. Students see science as a way of dealing with problems

**Process**

1. Students see science processes as skills scientists possess

2. Students see processes as something to practice as a course requirement

3. Teacher concerns for process are not understood by students, especially since they rarely affect the course grades

4. Students see science processes as abstract, glorified, unattainable skills that are unapproachable for them

1. Students see science processes as skills they can use and develop more fully for themselves

2. Students see processes as skills they need to refine

3. Students readily see the relationship of science processes to their own actions

4. Students see processes as vital parts of what they do in science classes

**Knowledge**

1. Knowledge is really information mastered for a teacher test

2. Knowledge is seen as an outcome itself

3. Learning is principally for testing

4. Retention is very short-lived

1. Students see science knowledge as personally useful

2. Knowledge is seen as a needed commodity for dealing with problems

3. Learning occurs because of activity; it is an important happening but not a focus in and of itself

4. Students who learn by experience retain it and can often relate it to new situations

**Figure 1 Differences in traditional vs STS science in relation to domains**

STS efforts have moved forward with dramatic pace during the ten years since Project Synthesis. STS is becoming the megatrend that Rustum Roy proclaimed it to be. STS activities are exciting and innovative developments in every state. STS programs are affecting the entire school curriculum, not just the nature of science courses and teaching. Exemplary programs represent major efforts and successes with realising the priority needs identified ten years ago by the Project Synthesis research team. Perhaps it is time for a second Synthesis study to note with certainty the extent that STS programs have resolved the science education issues so clearly identified in 1978.

**References**


**About the author**

Robert E Yager is Professor of Science Education at the Science Education Center, University of Iowa, Iowa City, Iowa 52242, USA. Dr Yager, a past president of NABT, AETS, NARST and NSTA, was presented with the Presidential Award of the National Science Supervisors Association earlier this year. He is continuing to play a key role in the development of STS education.
Resources

Women Too in Science and Technology in Africa
by Jan Harding and Emmanuel Apea

This new resource book (140 pages), written by Jan Harding and Emmanuel Apea with contributions by Kabiru Kinyanjui and Eddah Gachukia, has just been published by the Commonwealth Secretariat.

Few girls and young women become skilled in science and technology; this means that girls and women are largely excluded from participating in many areas of development. The Commonwealth Secretariat has tried to raise awareness of gender biases in science, technology and mathematics education in Africa in a variety of ways.

This book is intended to be a resource book of information about women already working as scientists and technologists, so that they may serve as role models to girls in schools. It may challenge the stereotyped assumptions of their teachers and parents too.

In addition to interviews with eminent women, the book looks briefly at the Commonwealth Plan of Action on Women and Development, current thinking about women and development, the role of science and technology in development, and what needs to be done to enable women to participate in development in scientific and technological fields. However, it is primarily a resource book for educators and scientists, for schools and institutions not only in Africa but in other regions of the world as well.

Copies are available, free of charge, from:
The Director
Education Program
Human Resource Development Group
Commonwealth Secretariat
Marlborough House
Pall, London SW1Y 5HX
UK

WINDBOWS INTO SCIENCE CLASSROOMS

PROBLEMS ASSOCIATED WITH HIGHER-LEVEL COGNITIVE LEARNING

Edited by Kenneth Tobin, Jane Butler Kahle and Barry Fraser

Based on recent ethnographic research, this qualitative study records, interprets and analyses actual occurrences in the science classroom. In addition, the researchers place their results in a theoretical framework. Individually, they record and interpret observations, while collectively, they validate assertions and interpretations in order to build a theoretical base.

Chapter 1: Learning Science with Understanding: In Search of the Holy Grail?
Chapter 2: Methods and Background
Chapter 3: Teacher Mind Frames and Science Learning
Chapter 4: Real Students Take Chemistry and Physics: Gender Issues
Chapter 5: The Cognitive Level of Curriculum and Instruction: Teaching the Four R's
Chapter 6: Student Participation and Motivational Orientations: What Students do in Science
Chapter 7: Students' Perceptions of their Classroom Environments
Chapter 8: Conclusion: Barriers to Higher-Level Cognitive Learning in Science

Published by Falmer Press, 1990 (264 pages)
Paperback US$20 Hardcover US$40

Order from Falmer Press, 1900 Frost Road, Bristol PA 19007-1598, USA

Individualised Classroom Environment Questionnaire

The ICEQ assesses perceptions of five aspects of classroom climate which are salient in individualised or open settings - Personalisation, Participation, Independence, Investigation and Differentiation. There are several different forms of the questionnaire:
* actual form (what the classroom is like) or preferred form (what students would prefer the class to be like
* student or teacher forms
* long form (50 items) or short form (25 items)

Copyright exemptions permit the ICEQ, after initial purchase, to be reproduced for use within schools. The ICEQ can be used in many applications, including the evaluation of new curricula, practical attempts to improve classrooms and investigations of differences between students' and teachers' perceptions.

The comprehensive handbook includes the various forms of the ICEQ, answer sheets and information about development, scoring and applications. It is published by the Australian Council for Educational Research (40 pages, quarto size) at a cost of A$49.95.

Order from: ACER, PO Box 210, Hawthorn, Victoria 3122, Australia
ICASE is keen to arrange regional or world events for the benefit of member associations. If your association or organisation is interested in hosting an international seminar, workshop or conference, contact the Executive Secretary or your Regional Representative. To gain ICASE endorsement, the meeting must be international in nature, open to member associations, and, while all sectors of the science education community should be encouraged to participate, must be relevant to classroom teachers.

1990

December 27 - January 1
International Conference on Teaching of Physics
Location: Karachi, Pakistan
Contact: Mrs Aziz F Hasnain, Head, Department of Physics, APWA Government College for Women, F 'B' Area, Karachi, Pakistan
The theme is *The changing face of physics education in developing countries*. The conference aims to discuss techniques for conceptual teaching in physics, to create awareness among physics teachers about modern teaching methods including the use of computers and audiovisual aids, and to establish a research program in physics education.

1991

January 4-7
ASE Annual Meeting
Location: University of Birmingham, Birmingham, UK
Contact: Annual Meeting Secretary, ASE Headquarters, College Lane, Hatfield AL10 9AA, UK
A special feature of this large international meeting will be an ICASE Symposium "Science Teachers Associations Worldwide".

March 18-28
Computer Science in Schools
Location: Homerton College, Cambridge, UK
Contact: Courses Department, The British Council, 10 Spring Gardens, London SW1A 2BN, UK
This residential course will focus on the application of computers in business, commerce and industry. Teachers will have the opportunity to use software, develop teaching materials and strategies. Different approaches to computer science will be reviewed and there will be an opportunity to exchange personal experiences. Participants should be those involved in the teaching of computer science to school students aged from 11-18 years. Application forms are available from British Council offices or the address above.

March 27-30
NSTA National Convention
Location: Houston, Texas, USA
Contact: Linda Crow, Asst Professor, Baylor College of Medicine, One Baylor Plaza, Room 633E, Houston, Texas 77030, USA
International delegates are invited to participate in The Fourth International Round Table. Each country is provided one or more tables in a large room where delegates can display and present information on science education in their country. While NSTA cannot offer any funding, an official letter will be issued on request, inviting international delegates to contribute to the program. Contact Prof John Penick, Science Education Center, University of Iowa, 450 Van Allen Hall, Iowa City, IA 52242, USA prior to 15 January in order for your name to appear in the official program.

March 29 - April 3
7th ICASE-Asian Symposium
Location: East China Normal University, Shanghai, China
Contact: Prof Mi Zihong, Department of Physics, East China Normal University, Shanghai 200062, China
The symposium will be conducted in English/Mandarin and will address the theme *Making science education in schools more relevant*. The program will focus on (1) the development of appropriate curricula, the issue of integrated science vs separate sciences, the introduction of STS in science courses; (2) innovations in teaching, the role of project work, the teaching of science communication skills, low cost equipment, fieldwork; (3) technology in education, the effective use of visual aids, visits to industry, the place of the computer; and (4) research in science education, children's learning in science, assessment techniques. The program will consist of presentations by internationally renown science educators; papers, workshop and discussion sessions; poster displays; and an exhibition.

April 1-14
Edinburgh International Science Festival
Location: Edinburgh, Scotland, UK
Contact: Edinburgh Science Festival Ltd, 20 Torphichen Street, Edinburgh EH3 8JB, Scotland, UK
There is something of interest for everyone at the international science festival. Now in its third year, this lively celebration of all the sciences, from astronomy to
zooology, is geared as much for those who are merely curious
or concerned about the world as it is for the serious scientist.
The 1991 festival will focus on the human body, but many
other topics as diverse as wildlife and artificial intelligence,
and biotechnology and electronics will be covered in an
extensive program of demonstrations, debates, exhibitions,
films, workshops, walks and talks. A full program is
available from the contact above.

April 5-8
Chemistry and Developing Countries
Location: Imperial College, London, UK
Contact: Stanley S Langer, The Royal Society of Chemistry,
Burlington House, Piccadilly, London W1V 0BN, UK
This conference will be the second organised by The Royal
Society of Chemistry on the theme of chemistry and
development. The 1991 conference, to be organised as part of
the celebrations to mark the 150th Anniversary of the
Society, will focus on two themes: (1) chemistry for the
environment, and (2) organising science to benefit the third
world. Representatives of several chemical associations from
around the world will be invited to present their views of
problems and opportunities.

July
Annual Conference of ASERA
Location: Brisbane, Australia
Contact: Dr Cam McRobbie, Queensland University of
Technology - Kelvin Grove Campus, Locked Bag No 2, Red
Hill, Qld 4059, Australia
All those interested in science education research are invited
to attend the 22nd Annual Conference of the Australian
Science Education Research Association.

July 7-12
CONASTA 40
Location: Adelaide, Australia
Contact: Anthony Diercks, SASTA Office, 163A Greenhill
Road, Parkside, SA 5063, Australia
The Australian Science Teachers Association invites you to
participate in the fortieth annual conference of the Australian
Science Teachers Association.

July 14-19
GASAT 6 International Conference
Location: University of Melbourne, Victoria, Australia
Contact: Ms Gaell Hildebrand, School of Education,
University of Melbourne, Parkville, Victoria 3052, Australia
The conference theme is Action for Equity: The Second
Decade. During the past decade, the GASAT Community
has explored the nature of the interaction between gender and
science and technology, and debated a variety of explanations
and solutions. GASAT 6 will focus on reflections upon past
GASAT work, current initiatives relating to intervention and
research, and perspectives on the challenges of the future.

August 4-9
ChemEd 91 Conference
Location: Oshkosh, Wisconsin, USA
Contact: Bruce G Smith, Co-Director, Appleton High
School-West, Appleton, Wisconsin 54914, USA or Paul
Kelter, University of Wisconsin, Oshkosh, Wisconsin
54901, USA
ChemEd 91 is a major chemical education conference of
interest to university, college, secondary and elementary
educators from North America and beyond. Throughout the
weeklong conference, activities are planned for all members
of the family including excursions, field trips, sports
activities and social events - a feature of ChemEd
conferences.

August 25-30
11th International Conference on Chemical
Education
Location: University of York, York, UK
Contact: Dr John F Gibson, ICCE 11, Royal Society of
Chemistry, Burlington House, Piccadilly,
London W1V 0BN, UK
This biennial conference on the theme Bringing Chemistry
to Life is being organised by the IUPAC Committee on
Teaching of Chemistry in conjunction with UNESCO and
the Association for Science Education. The conference will
focus on (1) making chemistry accessible to all students (2)
new curricula at primary, secondary and post-secondary levels
(3) new teaching strategies at all levels (4) teaching and
learning at a distance (5) new frontiers of chemistry and their

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Contact: Dennis Chisman, ICASE Honorary Treasurer
Knapp Hill, South Harting, Petersfield GU31 5LR, UK
or your local association
impact on teaching, and (6) research in chemical education. The program will include plenary lectures, poster papers, symposia, workshops, exhibitions, times for participants to discuss aspects of chemical education of special interest, social events and local visits.

August 12-22
Sixth International Symposium of IOSTE
Location: Wyndham Palm Springs Hotel and Resort, Palm Springs, California, USA
Contact: Dr Herbert K Brunkhorst, Institute for Science Education, California State University, 5500 University Parkway, San Bernardino, California 92440-2397, USA
The theme of the 6th International Symposium on World Trends in Science and Technology Education is Science and Technology Education: Responsible Change for the 21st Century. Science and technology education will be related to responsible change with respect to the role of science educators, scientists, engineers, business/industry and government agencies in the global community. The symposium will provide a forum for dialogue to increase awareness of regional perspectives worldwide and develop closer cooperation in addressing mutual concerns. This dialogue will be held in the context of science education issues, environmental issues, technology issues and socio-cultural issues. The symposium will be presented in English. Proposals for papers, including a brief abstract, should be submitted by 1st January.

August 26-30
Fourth Asian Chemical Congress
Location: Beijing, China
Contact: Prof Dehe Zhang, Secretary General of 4ACC, Chinese Chemical Society, PO Box 2709, Beijing 100080, China
The 4th Asian Chemical Congress will be held under the sponsorship of the Federation of Asian Chemical Societies. The Congress will focus on the important role of chemistry in raising the health conditions and living standards for all people. The program of plenary lectures, invited papers and contributed papers will be conducted in English and will concern various topics including organic chemistry of natural products, analytical chemistry and instrumentation, environmental chemistry, agrochemistry, coordination chemistry and its applications in medicine and agriculture, polymer science, photochemistry, computers in chemistry, catalysis, and chemical education.

August 27 - September 1
5th International Environmental Education Conference
Location: Cusco, Peru
Contact: MSc Eduardo Gil Mora, National University of Cusco, Zaguan del Cielo L-9, Cusco, Peru
The conference will focus on the relationship between the environment and development, and on the changes needed in today's behaviour for tomorrow's world. The program will enable participants to learn of developments, approaches and strategies in environmental education in different countries, and will cater for primary, secondary and tertiary educators; and for teacher trainers, curriculum developers, and policymakers.

1992

April 22-29
Symposium on Technology Education
Location: University College of Education, Erfurt, Germany
Contact: Prof D Blandow, University College of Education, Nordhäuserstraße 63, 5064 Erfurt, Germany
This symposium will be the first pan-European meeting on technology education to be held in a unified Germany - at an institution in Erfurt renowned for initiatives and developments in technology education. The principal aim of the symposium, which is being organised in collaboration with a number of organisations including ICASE and INISTE, will be to discuss technological literacy and competence in technology education within a European dimension. The majority of participants will be from European countries, with a few key people from other regions of the world. The principal language of the symposium will be English.

May 11-15
Second International History Philosophy and Science Teaching Conference
Location: Queen's University, Kingston, Ontario, Canada
Contact: Prof Skip Hills, Faculty of Education, Queen's University, Kingston, Ontario, Canada K7L 3N6
This conference follows the very successful First International Conference on History, Philosophy and Science Teaching held at Florida State University in November 1989. All conference papers will be published in advance of the conference. Accounts of the application of history and philosophy of science in the science classroom are welcome, as are research papers on the issue.

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Science Education International is the Quarterly Journal of the International Council of Associations for Science Education. ICASE was established in 1973 to extend and improve education in science for all children and youth by assisting member associations throughout the world.

This journal provides a means for associations, institutions, centres, foundations, companies and individuals concerned with science education, to share perspectives, concerns, ideas and information which will foster cooperative efforts to improve science education, and which will serve as a chronicle of the advancement of science education throughout the world.

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Dates for Receipt of Contributions

<table>
<thead>
<tr>
<th>Issue</th>
<th>Closing Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>March</td>
<td>1 February</td>
</tr>
<tr>
<td>June</td>
<td>1 May</td>
</tr>
<tr>
<td>September</td>
<td>1 August</td>
</tr>
<tr>
<td>December</td>
<td>1 November</td>
</tr>
</tbody>
</table>

ICASE News

Feature Articles
Curricular rhetoric: class teaching and examinations - a study of the new Nigerian science curriculum  
A U Adamu
Learning to manage our thinking  
D M Hill & J E Tuovinen
Greek primary science education: new textbooks and the national curriculum  
Z Z Kavogi

Science Education Around the World

Research for Teaching and Learning

The power of cooperative learning  
A Colburn & J E Penick

Science Teacher Education

Some recommended ways for including multicultural education in a preservice methods course  
G E O'Brien

Primary Science

Science Technology Society

Resources

Calendar

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1990 ICASE Distinguished Service Award

This award was presented to Mrs Sheila Haggis on 6th January 1991 at the Association for Science Education Annual Meeting in Birmingham, UK.

The following is part of the citation made by the ICASE President, Mr Bob Lepischak at the Presentation Ceremony.

The award is reserved for individuals who have a career history of distinguished service to international science education. Such service is characterised by consistent involvement in the international activities of local, regional and global science teacher organisations.

Mrs Haggis, educated at the University of Cambridge, began her teaching career in Nigeria and Ghana as a missionary teacher. It was on her initiative that GAST, the Ghana Association for Science Teachers was established...the Association has completed 33 years of service to science teachers.

For the past 25 years, Mrs Haggis has served as a Unesco staff member in Paris, most of the time responsible for science education within Unesco as Chief of the Science Education Section.

As part of a forward looking group, Mrs Haggis was responsible for facilitating the Preliminary Meeting of Science Teacher Associations held in Singapore in 1972; and in April 1973 was largely responsible for the inaugural meeting of ICASE held in Maryland, USA.

Mrs Haggis has participated in ICASE sponsored and endorsed events and meetings around the world providing counsel and enhancing the ICASE network.

With this award, Mrs Haggis joins an exclusive alumni of like-minded educators extending from Australia to the Caribbean, and from Singapore and the Philippines to the United States and Canada. In 17 years, the award has been presented to only seven other individuals.

Colleagues of Mrs Haggis admire her for her efficiency and her “stick-to-it-iveness”...she is considered an exemplary colleague, an individual with vision, and a gracious person. ICASE, and indeed education in general, is richer for the contribution made by Mrs Haggis.

For further information about ICASE Awards, write to:

Dr Jack Holbrook
Executive Secretary, ICASE
The Royal Society of Chemistry
Burlington House
Picadilly W1A 2BN, UK

Who's Who in Science Education Around the World

At the ICASE Executive Meeting held in Birmingham, UK in January 1991, it was decided to postpone publication of the Who's Who in Science Education Around the World 1991 Edition until late 1991.

This valuable reference book will contain profiles on prominent science educators and their work. The Executive decided to enhance this biographical volume by including details of science teacher associations around the world, and a brief profile on the science education scene in countries around the world.

It is not too late to submit details of prominent women and men and their work in the areas of primary, secondary and tertiary science education. Your recommendations are welcome. Forms for completion are available from:

Brendon Honeymon
The Editor
Who's Who in Science Education
10 Hawken Street, Monash ACT 2904
Australia

Photo: The President of ICASE, Mr Bob Lepischak, presenting the 1990 ICASE Distinguished Service Award to Mrs Sheila Haggis in recognition for outstanding service to international science education.
ICASE Executive Meets in Birmingham

by Brenton Honeyman
ICASE Journal Editor

Members of the ICASE Executive met from 31 December to 3 January 1991 in Birmingham, UK prior to the ASE Annual Meeting. Full minutes of this four day meeting will be sent to all ICASE members - some of the outcomes are summarised here.

World Conference 93
ICASE has commenced planning, in conjunction with UNESCO, a major world conference on Scientific and Technological Literacy: Forward to the Next Century, to be held in Paris, July 1993. A planning subgroup met during the executive meeting to prepare a detailed proposal for this event. It is hoped that the outcomes of a number of conferences being held in various places around the world during 1992, will provide a significant input into the agenda of the 1993 World Conference.

History of ICASE
In 1993, ICASE will celebrate its 20th anniversary. To commemorate this occasion, Dennis Chisman, Honorary Treasurer, is coordinating the publication of the history of ICASE.

Membership Dues Increase
ICASE Membership Dues are to increase by 10% from 1 July 1991. Member associations and bodies paying their 1991 dues prior to this date will avoid this increase.

Five Year Development Plan
A subgroup of the Executive Committee met to commence the development of a 5 year plan, involving development of five major areas - profile; financial base; services to members; human resources; policy development and operations.

Publications
The number of pages of Science Education International is to increase, but individual and library subscription rates will remain the same for 1991. Another new development will be the inclusion of some articles in French and other languages. Claude Gadbois, Special Projects Officer (French) has joined the Editorial Team to assist with this new initiative. Additional individual and library subscriptions will be encouraged during 1991. A scheme, where a local association can receive subscriptions to assist those who have difficulty in paying in other than their local currency, will be introduced during 1991.

The Executive Committee gave approval for the Proceedings of the ICASE European Symposium on Industry and Education (held in Brussels in 1990) to be published as the 1990 ICASE Yearbook.

An information folder ICASE: The People and the Organisation is being compiled. The folder will contain a profile of the Executive Committee and those working on ICASE projects; a profile of ICASE projects and accomplishments since its inception; the ICASE 5 Year Plan; the Annual Report; illustrated list of ICASE publications; ICASE brochure and membership list; ICASE Position Statement on Science Education; Position Statement on ICASE relationships with member organisations, corporate bodies and other organisations; ICASE Constitution. It is planned that documents within this folder will be available in English, and eventually in French and Spanish versions.

International Space Year
Four special International Space Year (ISY) activities involving ICASE were endorsed: (1) Publication of a set of space science resource materials for science teachers (a joint project with the ICSU Committee on Teaching of Science); (2) World Activity Day on Space Science, scheduled for October 1992 and to be promoted through ICASE member associations; (3) International Invited Conference Space Enough to Learn, to be held in Canberra, Australia, 13-17 July 1992; and (4) ICASE delegation to participate in the Space Science Seminar at Johnson Space Center, Houston, USA in 1992. Dr David Moore, UK, was appointed as the Project Officer coordinating ICASE involvement in these ISY Projects.
ICASE approaches 100 members
by Dr Jack Holbrook
Executive Secretary, ICASE

ICASE membership, as of January 1991, has reached 97, made up of 55 full members, 18 associate members, 19 institutional members, 1 foundation member, and 4 company members. In the past year, 10 new members have joined ICASE. The new members are:

- Quebec Science Teachers (QUEST), Canada
- European Youth Science Network (EURYSN)
- University College of Education, Erfurt, Germany
- Institute for the Promotion of Science Education, Pakistan
- Education Division of the Royal Society of Chemistry, UK
- The Zoological Society of London, Regent's Park, UK
- London International Youth Science Fortnight (LIYSF), UK
- Standing Conference on Schools' Science and Technology (SCSST), UK
- University of Toledo, USA
- Association of Biology and Agricultural Technology Teachers, Vietnam

London International Youth Science Fortnight

ICASE welcomes the LIYSF as an institutional member.

Each year, since 1959, the London International Youth Science Fortnight has brought together students of the Sciences of university entrance standard to share a program of lectures, seminars, discussions and debates, intermingled with visits to scientific, research and university establishments throughout southern England, in the London area and at Oxford and Cambridge.

In 1990, some 360 students - many of whom were award winners in Science Fairs and other competitions - from 50 countries took part in the meeting. The academic standards are high amongst the participants and are matched by those who give lectures and lead seminars - nobel laureates, university professors and eminent academics all contribute to the program.

Apart from the scientific program, the Science Fortnight offers a unique opportunity to live in an international community. Accommodation is arranged in University of London Halls of Residence, together with opportunities for social interchange at discos, international cabaret evenings and optional excursions to places of interest at weekends.

The Science Fortnight is the principal international youth meeting annually organised in Britain, and is the major international meeting of young scientists in the world.

Details of participation and the 1991 program are available from:

George McGowan
Director, LIYSF
PO Box 159
London SW10 9QX, UK
Tel 071 373 4568
Fax 071 835 1070

Standing Conference on Schools' Science and Technology

The Standing Conference on Schools' Science and Technology is the newest associate member of the ICASE family. SCSST was established in 1971, at the instigation of HRH The Duke of Edinburgh, to promote and encourage the development of science and technology in schools with particular reference to their economic and industrial applications.

SCSST is an independent national organisation whose corporate membership includes the leading organisations in education, industry, science, engineering and government departments. Through its activities, SCSST aims to:

- influence public policy on science and technology education
- sponsor innovation in the teaching of science and technology
- provide local support to schools through the SATRO network

SCSST is an educational charity supported by DES (Department of Education and Science), DTI (Department of Trade and Industry), industry, the science and engineering professions, and its member organisations.
Stepping into Science
A Report from Muscat

by Yunus Sola
Science/Accessment Coordinator, British School Muscat

Stepping into Science is a very important tool for motivating pupils. The project was initiated by Sue Dale Tunnicliffe, who is now Head of Education at the Zoological Society of London and the ICASE Project Officer for this worldwide project.

The project targets primary/elementary schools. Until now, award projects have concentrated on middle and secondary schooling. Stepping into Science is the first truly international award project designed for primary and elementary schools. It involves pupils doing a number of science tasks and investigations for which they are awarded a certificate. Any school and any teacher in the world can become involved.

Although the project is in its early development stage, it has already been implemented in some schools in England and abroad.

Teachers and schools around the world are invited to register, and take a "Step into Science". There is no fee and, upon registering, teachers can obtain certificates free of charge by writing to Yunus Sola at the address below.

The suggested framework is that each child should participate in about 6 tasks or investigations per year. A certificate is awarded to each child either as soon as they have completed these activities or at the end of the year. Of course, children may complete more than 6 activities per year. In fact, science coordinators and class teachers may adapt the scheme and the awarding of certificates to best serve the needs of their school. For example, at the British School in Muscat, Oman, I am using the project to support the Science in the National Curriculum which the school has implemented in line with England and Wales.

The award scheme has been organised to encourage children to take steps in science each year during their primary school years. These steps are colour coded as follows:

- yellow for preschoolers
- green for grade 1 children
- blue for grade 2 children
- red for grade 3 children
- orange for grade 4 children
- grey for grade 5 children
- purple for grade 6 children

Using this scheme, children in class 1 take the green step (consisting of about 6 activities appropriate for that level); children in class 2 take the blue step; and so on. The philosophy of the project is to give teachers the professional responsibility to manage the award scheme. It is up to the teacher to ensure that children complete the prescribed number of science tasks. The certificate scheme should not be used in a pass/fail sense, but should be used to acknowledge participation in, and completion of science tasks.

At the British School Muscat, the response has been very positive. Pupils love the idea, and enjoy the thought of being awarded certificates as part of an international project. Parents are thrilled that the school is involved in such an international award scheme. By being involved in this project, the Science Department has enhanced its status in the school community.

Heads of Science please note - I have found that teachers are more willing to organise science activities when they know that their children will be awarded certificates.

All schools will benefit by becoming involved in the Stepping into Science project - remember that the award scheme can be adapted to meet the individual needs of schools.

BP Middle East (Oman) Ltd have been very generous in covering the cost of printing and posting certificates to schools. On behalf of the Project Coordinating Committee, my sincere thanks go to BP for sponsoring this project.

To register your school, or for more information, write to:

Mr Yunus Sola
Stepping into Science
Project Coordinating Committee
16 Willoughby Road
London N8 0JE
UK

Yunus Sola is the Science/Accessment Coordinator at the British School Muscat in Oman. He is a member of the Project Coordinating Committee for the ICASE Stepping into Science Project, and the Coordinator for the International Science Award Scheme.
Curricular Rhetoric
Class Teaching and Examinations
A Study of the New Nigerian Science Curriculum

by Abdulla Uba Adamu
Department of Education
Bayoer University, Kano
PMB 3011
Kano State, Nigeria

Introduction
Like most developing countries, Nigeria sees rapid social and economic development through a systematic process of scientific manpower training and education, a view closely connected with the effects of the waves of science education reform movements in other countries of the early 1960s.

After political independence from Britain in 1960, dissatisfaction with the emphases of the then existing West African Examinations Council science curriculum designed in the 1950s set in rapidly in Nigeria. As a consequence, a new National Policy on Education was introduced in Nigeria in 1977 based on a 6-3-3-4 format which allocates six years in primary schools (starting from 1977), three years each for Junior Secondary Schools (from 1982) and Senior Secondary Schools (from 1985), and four years for a standard university degree (from 1988). However, the new policy is generally accepted to have started fully operating from 1982 with the Junior Secondary School phase.

The most distinctive characteristics of the new educational system are its orientation towards technical education in the Junior School, and an introduction of a new post-sputnik science curriculum in the Senior School advocating for a 'process' approach to teaching science subjects. These are all characteristics aimed at making secondary education in Nigeria consistent with self-reliance and national development (Nigeria, 1981).

This paper analyses the new Nigerian Senior Secondary School science curriculum against the background of the interpretation of the curriculum in schools by teachers and the abilities tested by new science examinations of the new system. This should enable judgments to be made about whether the examination encourages the development of abilities which the curriculum developers state should characterise science teaching and learning in Nigeria. The analysis should also provide an insight about the extent to which the new science curriculum could be used as an index for future social and economic development of Nigeria through science curriculum development.

Research Procedures
This paper is structured around the findings of the following research questions:

(1) What are the structural characteristics of the new Nigerian science curriculum?

(2) How are science subjects taught in secondary schools under the new curricular guidelines?

(3) What skills do the examination questions of the new curriculum encourage in children?

Three main data collection and analytical strategies were used in the course of the investigation. The first strategy was the analysis of the distribution of performance objectives in three science curricular guidelines (Biology, Chemistry and Physics) issued by the Nigerian government. This was to determine the emphasis of these curricula in terms of their statements of behavioural objectives for all the three science subjects.

The performance objectives in all the three subjects were analysed at the same time for comparative purposes, as well as to show the curriculum developers' relative expectations for each subject according to the three domains of learning - cognitive, psychomotor and affective. The strategy involved counting all the performance objectives stated for all the topics of the three subjects and categorising them according to the leading words used to state each in the domain that best suits the expectations of the objective.

The second research strategy involved classroom observations of science teaching in four Senior Secondary Schools in Kano State, one of the 21 states of Nigeria. This was done through a specially developed observation schedule (after Eggleston 1975, and Alexander, 1974) as part of the field work carried out for a larger study (Adamu, 1988). The aim of the observations was to determine science teachers' interpretation of the new curriculum in practice. A total of 15 teachers were observed teaching 28 Biology and Physics lessons in four senior classes (SS II, equivalent to Form V in the former system) in each school. The observations lasted six months during which 2455 minutes of classroom interactions between teachers and students were recorded.

Thirdly, using the statement of behavioural objectives in the three science curricular guidelines as a framework, the individual examination questions in theory papers of the newly introduced (June 1988) ordinary level Senior School Certificate Examination (SSCE) were categorised according to the skills and abilities the questions appeared to encourage and test. The analysis of the individual questions and sub-questions of the Nigerian SSCE yielded a picture of the general distribution of skills encouraged by the SSCE.
Table 1
DISTRIBUTION OF PERFORMANCE OBJECTIVES IN THE NIGERIAN SCIENCE CURRICULUM

<table>
<thead>
<tr>
<th>SUBJECT</th>
<th>COGNITIVE DOMAIN</th>
<th>PSYCHOMOTOR</th>
<th>TOTAL</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>K</td>
<td>C</td>
<td>A</td>
</tr>
<tr>
<td>Biology</td>
<td>119</td>
<td>123</td>
<td>57</td>
</tr>
<tr>
<td>Chemistry</td>
<td>52</td>
<td>65</td>
<td>30</td>
</tr>
<tr>
<td>Physics</td>
<td>92</td>
<td>56</td>
<td>52</td>
</tr>
<tr>
<td>Total</td>
<td>263</td>
<td>244</td>
<td>139</td>
</tr>
</tbody>
</table>

Key: K = Knowledge  C = Comprehension  A = Application  S = Synthesis

Structure of the Nigerian Science Curriculum

A quite striking feature of the new Nigerian science curriculum is its structure. This radically differs from what was used in the country prior to 1985 - which was actually an examination syllabus (WAEC, 1985). In providing the rationale for the structure of the new curriculum, the performance objectives of each topic in the three science subjects were stated in the three broad categories of cognitive, psychomotor and affective domains of Bloom's Taxonomy of Educational Objectives (Bloom et al, 1956). The analysis indicates that the overall distribution of the performance objectives is not even among the three clusters of objectives, as indicated in Table 1 above.

As Table 1 suggests, most of the performance objectives were stated in the cognitive domain, where 263 of the objectives were stated at the knowledge level. This is followed by 244 comprehension items. These two constituted the largest categories of objectives in the cognitive domain as stated in the Nigerian science curriculum. Fewer objectives were stated in the applications and synthesis levels.

Of all the three subjects, Physics appears to be the most practical science subject in Nigeria, since 38 performance objectives were stated with psychomotor achievement in mind. Chemistry turned out to be more descriptive than Biology because only 17 objectives tested the psychomotor domain as compared to 25 in Biology. This, however, is a reflection of the greater number of stated performance objectives in the Biology curricular guideline.

Classroom Teaching Strategies and Emphases

The second level of analysis of the science curriculum involves classroom observations during the teaching of Biology and Chemistry in four Senior Secondary Schools. This is to determine whether teaching science is consistent with the curriculum developers' expectations.

What makes judgment easier is the explicit statement of the suggested teaching approaches for all the science subjects in the curriculum. As further stated in the Physics curricular guidelines, as an example, teachers are strongly encouraged to employ the student-activity based and inquiry oriented mode of teaching (NERC, 1985).

The results of the six month observations of Biology and Physics teaching in four Senior Schools of Kano State in Table 2 below indicate the extent to which teachers interpret these guidelines during class teaching.

Table 2
SCIENCE TEACHING IN KANO STATE SECONDARY SCHOOLS
FREQUENCY OF TIME SPENT IN VARIOUS ACTIVITIES

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>FREQUENCY</th>
<th>MINUTES DURATION</th>
<th>%</th>
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<tr>
<td>Settling down</td>
<td>45</td>
<td>225</td>
<td>9.16</td>
</tr>
<tr>
<td>Teacher talks and introduces topic</td>
<td>37</td>
<td>185</td>
<td>7.53</td>
</tr>
<tr>
<td>Teacher talks and reviews topic</td>
<td>28</td>
<td>140</td>
<td>5.70</td>
</tr>
<tr>
<td>Teacher talks and expands explanation of topic</td>
<td>266</td>
<td>1330</td>
<td>54.17</td>
</tr>
<tr>
<td>Students ask questions</td>
<td>17</td>
<td>85</td>
<td>3.46</td>
</tr>
<tr>
<td>Teacher asks questions</td>
<td>15</td>
<td>75</td>
<td>3.05</td>
</tr>
<tr>
<td>Teacher refers to text</td>
<td>14</td>
<td>70</td>
<td>2.85</td>
</tr>
<tr>
<td>Teacher writes on board for students to copy</td>
<td>55</td>
<td>275</td>
<td>11.20</td>
</tr>
<tr>
<td>Teacher demonstrates activity</td>
<td>9</td>
<td>45</td>
<td>1.83</td>
</tr>
<tr>
<td>Students carry out activity</td>
<td>5</td>
<td>25</td>
<td>1.01</td>
</tr>
<tr>
<td>Class discussion of activity</td>
<td>0</td>
<td>0</td>
<td>0.00</td>
</tr>
</tbody>
</table>
It is thus significant that the teachers' emphases during Biology and Physics teaching in the observed schools differ markedly from the advocated teaching methodology of the Nigerian science curriculum.

This is because, despite the urging of the science curriculum developers to the teachers to use what the developers see as 'inquiry oriented' techniques, about 54.7% of teaching time for the two science subjects was spent by the teachers expanding an explanation of a topic they started almost the moment they came into the classroom. And in all, about 73.3% of class time was dominated by teacher verbal behaviour. Actual student participation in the lessons accounted for less than 5% of the time spent during the lessons.

Emphasis of the new SSCE Examinations

The two stages of analyses done so far provide a framework around which the structure of the examination questions in the newly introduced SSCE could be better appreciated. The result of categorisation of the individual questions of Biology, Chemistry, and Physics theoretical papers of the SSCE into the learning behaviours encouraged by the question papers are indicated in Table 3 opposite.

Thus, although quite a few of the examination items were written to test comprehension, application and synthesis skills, nevertheless the largest category of skills the SSCE would seem to encourage in Nigerian students is knowledge of basic scientific information.

This is because 47.29% of the individual question items in the new Senior School Certificate Examination, which culminates the innovative nature of the new science curriculum in Nigeria, tended towards asking for items that would yield factual information, rather than testing reasoning skills.

Discussion

The analysis of the Nigerian science curriculum using three broad clusters of objectives (cognitive, psychomotor and affective) revealed a very surprising pattern of distribution. For a curriculum with general orientations towards active student participation, the Nigerian Science curriculum would appear to encourage the behaviours it sets out to eliminate during students' learning of science in Nigeria.

This is because the evidence from Table 1 suggests a prime emphasis towards stressing basic scientific knowledge in the curriculum, followed by comprehension skills. Other traits most commonly associated with learning science, and as declared in the rationale of the curriculum, such as the development of reasoning and psychomotor skills, as well as specific attitudes were either not emphasised, or found to a limited degree.

However, these emphases would seem to be recurrent in cases where attempts are made to make the science curriculum 'pupil oriented' - a character of the newer science curricula, especially in developing countries, where curricular attempts were aimed more at breaking the mould of the traditional world-view.

For instance, in an analysis of the Malaysian Integrated Science curriculum materials whose major intentions were to reduce emphasis on the recall of factual information in favour of encouraging the development of affective, psychomotor and higher order cognitive behaviours, Lewin discovered that despite this intention, "it is surprising to find that 53% of section objectives are specified at the knowledge level of the cognitive behaviour whilst only 18% of general objectives are." (Lewin, 1981)

Generally, the expectation that teachers could implement the curriculum they had had no hand in developing, assumes they are aware of, and agree with, the balance in the cognitive, psychomotor and affective expectations recommended by the science curriculum developers during their teaching. Not many Nigerian science teachers are capable of doing this due to the limited nature of their training. A typical response

| Table 3 |
|------------------|-----------------------|
| DISTRIBUTION OF SKILLS IN NIGERIAN ORDINARY LEVEL SCIENCE EXAMINATION PAPERS (1988) |
| CATEGORY | FREQUENCY | % |
| Knowledge | 35 | 47.29 |
| Comprehension | 18 | 24.32 |
| Application | 11 | 14.86 |
| Synthesis | 10 | 13.51 |
| Affective | 0 | 0.00 |
| Total | 74 | 100.00 |

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Who's Who in Science Education Around the World

1991 Edition

ICASE is compiling this valuable reference book containing profiles on prominent science educators and their work. In order to enhance the value of this reference work, it is important to include prominent women and men in the areas of primary, secondary and tertiary science education in many countries throughout the world. You are invited to recommend individuals for inclusion.

Please send names and addresses to:

The Editor, Who's Who in Science Education, 10 Hawken St, Monash ACT 2904, Australia

8
from a teacher summarises the general situation in Kano State:

"Personally for me there is this question of lack of experience. Sometimes I lag behind as regards the rate at which I go which I know arises because of my lack of teaching experience." (Interview transcript in Adamu, 1988)

Further, many Ministry of Education officials in Kano were not convinced that instructing or requesting science teachers to teach science in a specific way (for example, as suggested in the new science curriculum) would be useful. As a government official stated, there would be quite a few problems:

"... if you recommend a particular technique (of teaching science) to the teachers, it may not be known to the teachers. You have to realise that in Nigeria today, it is not all teachers who are in the classroom who are actually teachers. They don't even have the basic qualification for teaching." (Interview transcript in Adamu, 1988)

But disparity between what the curriculum developer (or administrator) aims at, and what teachers do in the classroom in implementing the same curriculum is emerging as a standard feature of science education reform, in both developing countries (Lewin 1981; Maddock 1981) and interestingly, in some developed countries such as Canada (Aikenhead 1984; Ste-Marie 1982).

For instance the report of various case studies of observations of science teaching in many Canadian schools revealed that senior-year teachers view science as a precise method and as a system of exact numbers, highly organised bodies of information, and specialized terminology. Their concern is to provide students with the notes and with the practice in solving problems that will result in high marks on examinations and allow the student to move through high school to university (Orpwood and Souque, 1984).

Thus in Nigeria, as in some other parts of the world, the predominance of teacher behaviour reflected in Table 2 casts doubts on any science curricular advocacy that invests more learning independence on the students. This is because such suggested science teaching advocacy rarely takes into consideration the educational realities of the schools - lack of qualified teachers, or facilities or both - as well as the school authorities' concern with covering the syllabus guidelines in the shortest time possible before the all important examination; a strategy which is inconsistent with the new science curricular pedagogy.

Finally, for a new curriculum that advocates a revolutionary perception of science teaching with emphasis on the learner, it would seem that the skills derived from the new curriculum and tested in the learner, lean more towards the ability of the student to recall basic scientific knowledge, instead of encouraging the student to display an understanding of science as a function of greater personal awareness and intellectual development consistent with the stated overall aims of the science curriculum.

And yet one of the rationales given for the development of the new science curriculum in Nigeria is to de-emphasise the power of the examination system on curriculum interpretation by both teachers and students. This is, for instance, indicated in a critique of the former science curriculum in Nigeria (WAEC, 1985) by a member of the team that developed the new Physics curriculum who observed that, prior to 1985 when the new curricula were introduced:

"In upper classes of the schools, the topics taught were in obedience to the stipulation of the examination board... No proper scientific skills and attitudes were acquired by the students." (Ivori, 1982)

But although these remarks were aimed at what was considered a redundant curriculum in a rapidly changing society, the same could very well apply to the new science curriculum.

From this, it would seem that the new SSCE was not supportive of the philosophical orientations of the new Nigerian science curriculum. And possibly due to this, teaching science in Kano State Senior Secondary Schools has become rigid, and less imaginative. It also seemed aimed at providing learning experiences directly relevant to enabling the students to pass their examinations.

Conclusions

This study confirms that examinations can exert pressures, albeit hidden, on teachers' interpretation of the curriculum in the classrooms, no matter how innovative the curriculum claims to be. This is significant in the implications it suggests for curriculum reformers and policy makers.

For instance, if a curriculum based on the process/enquiry approach to science teaching is taught didactically, then whatever the students achieve cannot be attributed to the enquiry approach.

This has far reaching consequences. This is because curriculum development in science education usually has strong social and political bases. Consequently science education projects, especially curricular reforms, are expected to result in more people in society knowing more about science and having a better understanding of the nature of scientific work. Often, curriculum development is also expected to encourage more young people to enter scientific and technological occupations. This paper has raised possibilities that the expectations that curriculum development can influence broader social and educational matters in Nigeria may be an uphill task.

Thus it is not enough to merely improve the curriculum by changing its objectives and introducing words with social and developmental dimensions. A whole new range of integrated science curriculum development strategies has to be developed for Nigeria. This should see science education not merely as a list of impressive and politically significant objectives which policy makers and curriculum developers hope will be attained by students, but as a dynamic classroom process which reflects itself both in its statements of intent and in the examination system.

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Communique of the 31st Annual Conference
Science Teachers Association of Nigeria
27 August - 1 September 1990

At its 31st Annual Conference, STAN formulated the following recommendations:

- Nigeria should embark on programs designed to achieve scientific literacy for all by the year 2000.
- Computer education should be introduced at all levels of education as soon as possible after necessary planning. In this connection, appropriate curricula should be drawn up, teachers should be trained and the necessary infrastructure and learning materials should be provided.
- Teachers should adopt a humanistic approach to teaching that will make the learning of STM attractive to the learner.
- STM curricula should be reviewed to ensure that they are based on the environment. STM teachers should also draw examples from their local environment. This will help to improve learning and also demystify science. The use of low cost equipment should also be emphasised.
- A well articulated integrated science program should form the foundation for achievement of scientific and technological literacy for all.
- The pre-service preparation of science teachers should be approached with a greater degree of seriousness than in the past. Serving teachers, inspectors and policy makers should be given in-service training so as to update them.
- All university faculties of education are urged to introduce degree programs in integrated science.
- Education research in STM should be directed towards strategies for improving the quality of lesson delivery as well as strategies for improving learning through problem solving.
- Since the primary school is the foundation level of education, the teaching of science at this level should be strengthened. In this connection, selected primary schools should be provided with good science facilities for the study of STM. JETS Clubs should be introduced in primary schools. Furthermore, JETS production centres should be set up in each local government area, where pupils can carry out projects, fabrications and copy technology.
- Specialist teachers should be allowed to teach science in the primary schools.
- Universities should strive to maintain the 60:40 ratio in the admission of candidates into science and non-science courses.
- A survey of the human and material resources required to attain the targets set for the 1990s should be undertaken within the next year.
- Federal and State governments should speed up the procurement, installation and maintenance of equipment for Introductory Technology.

Incentives in the form of inducement allowances should be given to STM teachers.

- To attain scientific literacy for all by the year 2000, STAN should write simple science supplementary readers and produce the same in the three major Nigerian languages.

Dr U M O Iwobi, fstan National President
Dr J O E Otuka, CPhy General Secretary
Learning to Manage our Thinking

by Douglas M Hill and Juhani E Tuovinen
Charles Sturt University - Riverina
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Anderson (1983) distinguished between knowing that (declarative knowledge) and knowing how (procedural knowledge) and suggested that both types of knowledge interacted in intellectual functioning. For example, domain specific knowledge and general thinking skills or cognitive strategies are needed to solve specific problems. Cognitive strategies are general intellectual skills such as "working out alternatives, judging the likelihood of success, reflecting on the meaning of new knowledge, searching out associations between the elements of knowledge, generalising and deducing." (White, 1988, p40). They also include other powerful procedures which are learned, such as:

"... keeping (one's) mind on the task, determining the goal, reflecting, weighing alternatives, and so on. These cognitive strategies determine the quality of performance in learning, in problem-solving and in day-to-day living. Of course, they operate in conjunction with specific knowledge there has to be a task, some information to absorb, a problem to solve, on which the strategies can be applied." (White, 1988, p83)

Problem-simplification (reduction) is a strategy which has been widely used in science. Mendel's seminal work on genetics provides a good example. Instead of trying to follow the inheritance of multiple characteristics be focused on single factors to identify a pattern. The same strategy was employed by Le Bel in developing the concept of structural isomers. He investigated the simplest organic compounds which existed in two forms and built models to show how such differences might be explained in terms of the possible spatial arrangements of components. Crick and Watson used similar techniques in deciphering the structure of DNA.

In our haste we often fail to draw students' attention to the way in which scientists have used this reductionist strategy, and its limitations. It provides the rationale for the development of skill in controlling variables in science at the secondary level.

The teacher training workshop activities which follow are designed to develop the simplification strategy. This strategy involves simplifying a problem situation, finding a pattern in the way the simplified problem can be solved and then trying out that pattern with the problem in its complex form. The workshop's set of three tasks can be run as follows:

Task 1 - 15 minutes
Refer to Task 1 on page 12. Few, if any, will be successful in the given time. The tutor should raise the issue of looking for a suitable strategy to tackle this type of problem - simplification will usually be suggested.

Task 2 - 20 minutes or more
Refer to Task 2 on page 13. The tutor should check to see if the simplification strategy is being used - if not, the tutor could ask about the similarities between tasks 1 and 2.

Task 3 - 40 minutes
The tutor sets the task of designing a problem which uses the simplification strategy. It may be framed in the LEGO TC context, for example to build a computer controlled merry-go-round. In such a problem, the development of modular programming technique would be developed, where a large complex problem is broken down into smaller manageable tasks which may be completed in a suitable sequence to carry out the larger enterprise. This could lead to the solution of a complex LOGO problem by building up the total solution from a number of simpler modules or procedures.

A complex problem could be considered, such as the behaviour of pourable solids when they pass through a suitable funnel and form a pile on a flat, level surface. A range of solids could be investigated including sand, tapioca, split peas, coffee crystals, table sugar, flour, rice, talcum powder, fine sawdust, soap flakes, polystyrene beads, etc. To solve this problem requires the use of the simplification strategy in the process of making decisions about what variables will be manipulated and which will be controlled.

Simplification strategies can also be developed by using suitable computer programs. A good example for primary and lower secondary levels is the Collamore Castle: Strategies for Problem Solving (Bradshaw & Boesch & Co, 1987). It is designed to cultivate strategies such as simplification and working backwards, and forms a useful illustrative and developmental component of a course dealing with problem solving techniques in science.

References

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Australia
Task 1

Shade in 4 of the 8 small squares

Cut out the 8 small squares

Turn the uncut grid of larger squares horizontally and place one of the shaded squares on each of the 4 squares on the left-hand side of the playing space (9 larger squares)

Place one of the unshaded squares on each of the 4 squares on the right-hand side of the playing space

You are now ready to play! The aim of the game is to get the shaded and unshaded squares to the opposite end of the playing space. Here are the rules:

- Squares can only move in one direction - shaded to the right, unshaded to the left

- Two squares cannot occupy the same playing space

- One square may jump another if there is an empty space on the other side

- Only one small square can be moved at a time
Task 2

Cut out the 5 squares of different sizes

Turn the remaining column of 3 large squares horizontally and place the largest square on the first left-hand playing space

Place the second largest square on top of the largest, and so on until there is a 'tower' of 5 squares. You are now ready to play the game!

The aim of the game is to transfer the tower from one end of the playing space to the other in as few moves as possible

The rules are that only one square can be moved at a time; and a smaller square must always be on top of a larger one

Find out the minimum number of moves needed to transfer the tower from end to end
Greek Primary Science Education
New Textbooks and the National Curriculum

by Dr Zoe Zoni Kavogi, Research Student
King's College London, University of London

Educational changes in Greece have been limited to the 'extrinsic re-arrangement' of Education (legislation, establishment of new types of schools, structure of schools, etc). They have not concentrated on the core of educational reality (intrinsic re-arrangement) - methodology, curriculum, books, teacher-training, etc. (Terzis, 1981) The new Greek National Curriculum includes four basic structural elements (Xohellis, 1981):

- Objective didactic targets
- Content
- Methods of teaching
- Testing

Changes in all the above elements may influence the qualitative results of classwork and, later on, Greek education as a whole.

Such viewpoints arose on the horizon of Greek Education at the time of the 'Educational Renaissance of 1976'. However, daily educational practice has shown that the ideology of technocracy exists - a new kind of control being established in education, and narrow limits on teachers' involvement.

The new National Curriculum was introduced gradually, starting in 1982, and applied by new textbooks. The new textbooks, which have been gradually introduced for the first time in primary education, cover the areas of Greek Language, Mathematics, Study of the Environment, Discovering the Natural World, and Social and Political Education.Already, there is considerable experience in their use and application in schools.

The new National Curriculum was written by the Department of Primary Education of the Pedagogic Institute - an important department of the Ministry of Education.

It was in 1964-65 that the first steps were taken to change educational policy and impose a new National Curriculum (Kazamias, 1983), only to be stopped by the 1967 dictatorship. Years later, a new attempt to change educational policy began - the 'Educational Renaissance of 1976'. However, it was not until 1982 that this policy was implemented in schools through a new National Curriculum and new textbooks.

The 1982 National Curriculum

The new law for the structure and function of Primary and Secondary Education is known as 'anti-309'. It is based on Bruner's theory for the structure of knowledge, and considers this theory to be the only acceptable one. The methodology for organising knowledge in the National Curriculum and new textbooks follows the prototypes of the USA and European countries but, while it emphasises the detailed planning of daily lessons, it ignores many other problems including social differences, school failure, the short time pupils spend in school - 25 to 30 hours per week - because of lack of buildings, etc.

The New Textbooks for Primary Education

These include programmed material for learning and methods of teaching in detail (quality, quantity, didactic actions and student activities, available time, evaluation of the success of learning targets, etc).

There is also a teacher's book for each subject and grade - a resource which all teachers had been waiting for. Each teacher's and pupil's book is the result of the work of groups of specialists - members of the Pedagogic Institute - organised under the guidance of the Ministry of Education. The new books include what teachers need to know and what pupils need to learn. For instance, the book for the pupil contains all student activities, exercises and questions in a pre-defined format. The book is a part of the didactic operation which is suggested by the teacher's book. (Pedagogic Institute, Ministry of Education, 1982). Demaras (1979) contends that "under the excuse of a qualitative improvement of the school book and the protection of pupils and parents from the high-handed acts of some editors, as also the excuse of student's release for the purpose of University and College books, the total control of educational books is under the National Authority". Hence, a common and compulsory book is imposed on all students at no cost to them. Its use is compulsory and exclusive if we bear in mind the prohibition against introducing other books and educational aids in schools (Pedagogic Institute, 1984).

Education legislation obliges teachers to comply with the guidelines of the Pedagogic Institute as expressed in the teacher's handbook.

Teachers' opinions are reflected in the research of M Danilidou (1984:87). To a certain extent the textbooks help them save time in preparing to teach. However, on many occasions they have found themselves incompletely prepared or lacking in knowledge, time or confidence to handle a new subject. Members of the Pedagogic Institute who have designed and written these textbooks claim that "they aim to protect the teacher from sketchy improvisation and insecurity" (Pedagogic Institute 1983:6).

Study of Environment

The new textbooks (four pupil's and teacher's texts for grades 1 to 4) should be examined from three different viewpoints:

1. From the viewpoint of their content

The textbook content in relation to the pupil's level of knowledge is critical. With regard to the scientific content there has been an improvement in the textbooks for primary
science education, and therefore are quite adequate, progressive and modern compared to the previous ones. However, they maintain similar frames of values and prototypes of behaviour.

Both "Study of Environment" and "Discovering the Natural World" have an integrated science structure. Both contain Physics, Chemistry, Biology, Environmental Studies, Geography, etc. Systematic educational research is required so that the level, the extension and the quality of the changes can be defined.

2. From the viewpoint of the new didactic methodology which is suggested

Research is indispensable in this direction. The first important study of both the above mentioned viewpoints has been done by M Danilidiou for the textbook 'Study of the Environment' for the first grade of Primary School. Included in it is an evaluation by twenty teachers. Having assessed content, vocabulary and terminology, pictures, etc. of the book, they have generally concluded that the content is more scientific and progressive, and that the suggested methodology seems to be accepted by many teachers (1984: 45).

3. From the viewpoint of the organisation of daily teaching practice as introduced by the new textbooks

More practical work is needed but is practically impossible because of lack of time, equipment, organisation of classroom, and teacher training. Although a seemingly neutral condition of the teaching operation is presented, in reality both the teaching process and pupil's learning are controlled by the predefined and detailed operations in the textbooks, which must be followed by both teachers and pupils.

The texts are full of encyclopaedic knowledge. They contain modern aspects of life, pollution of the environment, development of human conditions of life, peace, etc.

Some examples serve to illustrate what pupils learn about their world as they study this subject. In the chapter on 'family', children learn that man and woman are married for procreation of mankind without any personal choice. This idea is supported by the parallel presentation of animals' families. A similar example occurs in the chapter 'how people communicate'; an analogy is suggested - animals also communicate. The teacher's guide refers to the kinds of communications among deaf and mute people, and people who speak different languages. The authors do not consider human thinking as a higher mental operation which does not exist in animals. Furthermore, they do not consider that deaf and mute people, or speakers of different languages think during communication. In another chapter we find that all living beings have the same needs - food, water, housing and sleep; hence children are not able to understand the existence of other basic needs such as education and peace, nor that humans think at higher levels than animals. Also the topic concerning the destruction of nature from pollution is not presented seriously and in depth.

Finally, pupils can become confused about their surrounding world because of the learning approach used. Children have no 'live' contact with the object or situation they learn about, even though this is necessary in view of their young age. There is a lack of suitable equipment in schools (garden with flowers and animals, laboratory of physics and arts, viewing hall, etc). Opportunities for learning outside the classroom do not exist. There are pictures in the textbook and a teacher relies upon these pictures to supplement the written text. Observations, comparisons and associations are made by the children on the basis of the pictures - a mental exercise; first hand, accurate knowledge of the environment is not undertaken. Many educators and parents object to this approach to knowledge, where textbooks look like 'comics'.

Discovering the Natural World

The Pedagogic Institute holds the view that a critical analysis of these new textbooks - pupil's and teacher's texts for 5th and 6th grades - at the time of reception is untimely, since the books have not been evaluated in practical use. The specialists of the Pedagogic Institute advise that teachers use the textbook in the suggested way and make criticisms later on. This means that the responsibility for obtaining good results from the use of the new books is left on the shoulders of teachers.

Conferences and discussions within the Department of Education, the School of Postgraduate Studies for Primary Teachers and other educational bodies contend that research for evaluation and improvement of this book is imperative, and that special training is needed to enable teachers to cope with the problems in the use of the book, particularly in the area of scientific knowledge rather than the organisation and control of classroom activities. Experience so far is indicating that this textbook does not work in school practice.

Many concerns from teachers, parents and students have been raised about the content of these textbooks. Considerable scientific knowledge is required by teachers, but no inservice help is provided. Primary teachers' lack of scientific knowledge in the areas of Physics, Chemistry and Biology handicaps them as they try to teach the content in the right way. Both texts include too much material. A prescribed lesson for one teaching hour is often impossible to complete in one hour. The teacher often needs twice that time. In the teacher's text one finds only the organisation of the teaching process, without the additional information needed by teachers. Teachers need considerable preparation information and background explanations in order to teach a good lesson. They also need suitable equipment and material for the experiments.

Although both textbooks are attractive, many chapters do not follow a meaningful sequence. Teachers often are obliged to give more information for a chapter to be comprehended. Many mistakes can be found in the expression and formulation of physical meanings. The new textbooks include simple and attractive experiments, but these require suitable equipment and their formulation is not simple, so pupils are often not able to carry them out. Another disadvantage is that there is a great number of events for every lesson, all of which must be carried out during one lesson - an impossible task. Another negative point is the lack of writing space for pupils' observations and data during an event or experiment. These would give teachers the
opportunity to understand if pupils have gained anything during their experimenting, and to criticise their answers. The teaching process could then be improved.

Textbooks and Parents

The Ministry of Education has abolished home study for pupils at primary school. Study at home refers to various activities involving the collection of information from sources such as books, magazines, etc. From a young age, children learn to search, to express ideas correctly, and to conceive basic meanings of science - an important foundation for future learning.

The Pedagogic Institute advises teachers to rarely give, as homework, a passage from the textbook to be learnt by heart and 1-2 sentences for spelling (Pedagogic Institute 1984). This type of homework is useless and boring, is not accepted by teachers and pupils, and has a negative influence on children's learning, in particular the quality of their learning, their reaction to learning, and the availability of free time to be used in creative activities.

On the other hand, the abolition of homework takes away parents' opportunity to contribute to children's learning and to improve it or to correct children's mistakes. Parents have no chance to assess the quality of school education and, if necessary, to request improvement.

Many parents and teachers claim that the education offered by Greek schools is not appropriate for all pupils. The application of the new textbooks and National Curriculum, especially in the subjects of Mathematics, Discovering the Natural World, Study of the Environment, and Greek Language, has resulted in a great number of weak pupils. This is compounded by the less time pupils remain in school; teachers do not have enough time for explanations and parents need to offer further help at home through private paid lessons.

The Results

The content renewal of the subjects 'Study of Environment' and 'Discovering the Natural World' has produced the following results in school practice:

The time for teaching has not increased in proportion to the increased amount of content. This problem becomes larger in the case of certain types of schools. In remote rural areas in Greece there are (1) primary schools of six grades in one class, (2) primary schools of six grades in three classes where every class includes pupils of two grades. In these types of Primary Schools, the time available for each grade is shorter than in the usual Primary School class.

A trial period did not precede the wide application of the new National Curriculum. The benefits of pilot studies would have included improving the content of daily lessons, methodology, and number of exercises, and would have indicated the need for an additional hour of teaching time in order to complete the content in each lesson. As it is now, pupils are flooded every day with a large amount of knowledge - too much for them to assimilate. The fact that many lessons do not follow a logical sequence does not help either. If the teacher follows the guidance of the teacher's textbook, he/she ought to use some time from other activities (music, athletics, arts) to complete the lesson. In summary, these are the outcomes:

(1) The teaching rhythm of the two subjects is intensive producing anxiety in teachers and pupils, cognitive gaps and a lack of real learning according to teachers' reports. (2) Although the content theoretically corresponds to an ordinary pupil, in practice only high ability pupils can complete all the exercises; many pupils do not cope comfortably. (3) Serious research and evaluation of the new National Curriculum in Primary Science Education must be undertaken.

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Report on the 3rd Annual General Meeting
Galician Science Teachers Association
by Frutos Fernández González
President, ENCIGA

300 Galician science teachers attended the third Annual General Meeting of ENCIGA (Galician Science Teachers Association), held at the F.P. Institute of "A Pinguela" in Monforte de Lemos, Galicia, Spain, 8-10 November 1990.

The broad and diverse program involved more than 40 talks, workshops, experimental demonstrations, as well as poster sessions on physics, chemistry, natural sciences, mathematics and integrated science.

A subject which raised great interest was that of teacher training, since we are undergoing the introduction of a new educational system in Spain. Dominguez Castilleiras, Garcia Rodeja, Jimenez Aleixandre and Lorenzo Barral addressed the topic of initial training of future science teachers, and Grafa Carrodegus and Fernandez Fonticoba addressed the topic of inservice training of teachers.

Another recurring theme was about using students' social and cultural environment to increase student motivation and to enhance the social and cultural aspects of Science. Adela Vázquez talked about the importance of the environment as a material resource in developing a science curriculum, and shared her experiences, including activities with her students in hatcheries, greenhouses and hydroelectric stations.

Other sessions included Environmental Science Education by Tajes Gómez, teacher of IESP at La Coruña and the science staff of "Otero Pedrayo" High School, Orense; Astronomy by teachers of the group Antares; and Assessment.

The meeting also attracted many mathematics teachers, and there were a number of sessions focusing on mathematics topics. The Lua group from Lugo presented a session which exemplified mathematics games as hands-on experiences in teaching materials. Other topics addressed were the cultural value of mathematics (mathematics for all) by Antón Labrada; and assessment.

José María Pérez, nationally recognised expert in the computerisation of science teaching, spoke about semantic fields, semantic trees, automation and grammars in physics language, and about the computerisation of a syllabus.

The exhibition "Mathematical Horizons" which was featured throughout the 3 day meeting, will also tour three cities of Galicia. This event, organised by ENCIGA, will be visited by over 10000 students. The broad program which included social events, excursions, and visits to museums ensured that the Annual General Meeting was an enjoyable event - we're looking forward to the next meeting.

New York University
Science Education
Summer School
London, UK


Participants will visit British schools, meet with teachers and students, learn about current innovations in science and technology education, and complete a 6 credit graduate course in science education at the same time. This unique residential course takes place July 1-19 at the Roehampton Institute, Wimbledon, London, with senior faculty from both Britain and the United States providing the instruction.

For further information and application forms, contact Professor Graham Orwood, 200 East Building, New York University, New York, NY 10003, USA.

Canadians may write to 131 Bloor Street West, Suite 200, Box 326, Toronto, Ontario, Canada M5S 1R8.

Have you entered for a 1991 CASTME Award?

The awards of the Commonwealth Association of Science Technology and Mathematics Educators (CASTME) are intended to encourage teaching of the social aspects of science, technology and mathematics, with particular reference to developing countries of the Commonwealth. The scope of the awards is interpreted broadly, and social aspects includes the relevance of science, technology and mathematics curricula to local needs and conditions, and to the impact of technology, industry and agriculture on the local community. For entry forms, contact your local British Council office, or The British Council, 10 Spring Gardens, London SW1A 2BN.
Sustainable development - the new world agenda

Of concern to all of us are the pressing environmental and economic opportunities and challenges facing us today and influencing future generations. Sustainable development is a mind set which developed during the latter part of the last decade. It is a means by which our environment can be protected, our economy can grow and our society can be enhanced. Sustainable development depends on active involvement and participation by all sectors of the economy and society. As pro-active participants, citizens find solutions to problems, identify opportunities and mould the type of society that meets our needs and those of future generations.

The mandate of the World '90 Congress, held in Winnipeg, was multi-faceted. The conference was designed to attract a multi-sectoral audience representing government, industry, business, education, the general public, and youth. The congress was provincial, national and international in scope.

Curriculum model for sustainable development education

Education is the key to the success of a sustainable development agenda. To this end, the pre-conference focused on examining the application of sustainable development in formal curriculum. The pre-conference proceedings document will outline a curriculum model embracing sustainable development strategies as an integral component of K-12 education. The Canadian Association for Science Education (CASE)

President, Paul Barron, served as host/facilitator for the pre-conference event. Milton McClaren addressed the "state of the art of sustainable development in Canada". Joseph Sanders, President of Southern California Association of Science Specialists, presented conceptual dimensions of an integrated environmental education model. Anthea Maton presented the NSTA Scope, Sequence and Coordination Project - a restructuring of science education in the United States. Frank Allan, Curriculum Coordinator for the Ottawa Board of Education, provided an insight into "Global environmental issues and the school curriculum". The ten presentations provided substance for the Breakaway/Seminar Sessions where the "real work" of the pre-conference was done.

International scope of pre-conference

The pre-conference proceedings are being edited by Dennis Chisman, ICASE Honorary Treasurer, and Dr Jack Holbrook, ICASE Executive Secretary. The planning committee feels that the writing and editing by ICASE officers will help to eliminate a provincial or national bias.

Main Congress Event

The main congress event was a two and a half day conference offering to 2800 delegates, some 230 lectures, workshop sessions, forums and debates. The purpose was to provide an arena for information sharing, discussion, and cross-pollination of ideas. At the conclusion of each conference day, delegates were afforded an opportunity to participate in stakeholders sessions, which added suggestions, concerns, and resolutions to the fabric of the Manitoba Protocol, the main conference proceedings document.

International contributions to Manitoba Protocol

A truly national and international cast contributed to the main congress event. Dr Ghafoor-Ghaznawi, Chief of the Unesco Environmental Education Section, Paris, provided an overview of "Environmental education from 1977-1982". Professor Chris Baines of Birmingham, UK, examined a "Landscape full of life".

Robert Bateman, famous Canadian wildlife artist and conservationist, reminded us that "The best things in life aren't free anymore". Dr Amory Lovins of Colorado, USA, addressed the topic "Energy efficiency, environment and development". Ralph Winrich, NASA Aerospace Specialist from Ohio, USA, focused on "Global environmental concerns".

Dr Anatoly Shidlovsky, Director of the Institute for Electrodynamics in the Ukraine, explored the topic of "How ecological and economic factors influence energy resource development in the Ukraine". Dr Edgar Faust, Manager, Strategies Planning, Fungicides/Insecticides, Frankfurt, Germany, discussed "Staying alive in the 21st century".

World '90 was an event at the leading edge of a revolution in thought regarding our environment and future economic development. Its success will not be measured by the event but rather by those deliberations and events which will be facilitated by the Manitoba meeting.
Education for All
Meeting Basic Learning Needs
by Sheila M Haggis
Paris, France

It is now a year since the World Conference on Education for All was held in Jomtien, Thailand. Jointly sponsored by Unesco, the United Nations Development Program, Unicef and the World Bank, as well as 18 co-sponsors (governments and organisations), the Conference was spectacular by any standard. There were some 1500 participants, including delegates from 155 governments, and from a number of major governmental organisations. It was addressed by Heads of State and Ministers of Education as well as by many key policy-makers and specialists in education and other sectors of social and economic life.

At its closing session on 9 March, the Conference adopted by acclamation a "World Declaration on Education for All" and a "Framework for Action to Meet Basic Learning Needs". The texts were the product of a wide and systematic process of consultation during the year before the Conference, which included no less than 9 regional consultations. The Declaration states that every person - child, youth, adult - should benefit from educational opportunities to meet their basic learning needs. The Framework for Action is designed to help countries develop their own specific plans of action to meet this goal.

The "basic learning needs" as outlined at Jomtien call for educational opportunities not only to read and write but also to develop basic learning skills such as numeracy, problem solving and oral expression. There is, moreover, the need to acquire learning content - not only knowledge, but also the attitudes and values without which human beings can neither survive and live and work in dignity, nor make informed decisions and continue learning. It is here that scientific literacy, health and population education are indispensable. A series of Round Tables on these themes discussed the importance of broadening the concept of basic education to cover the corresponding content areas and the relevant skills. They affirmed that science and technology education must form part of education for all.

The Jomtien Conference has an important message for ICASE and for associations for science education world-wide. It is imperative for science and technology to form part of basic education in all countries and for the methodology used to be a practical one based on the learners' environment and placing a premium on their curiosity and creativity. For this to become a reality, teachers need support systems. There must be opportunities for them to communicate with colleagues - and what better forum for this than a professional association! There is also a need for their associations to act in concert as pressure groups to ensure that the curricula, the examinations and the text-books do not become fossilised, for then the very notion of "education for change" will wither.

The Conference also focused attention on the need for a "gravitational movement" causing the whole educational system to become more aware of and more sensitive to the ways in which scientific and technological innovations are changing the nature of work. As a consequence, workers need new skills, and the education and training they receive must be transformed. School curricula are often out of touch with the real needs of the world of work. Closer links with industry, the use of educational technology in more appropriate ways, and greater emphasis on design and technology in the curriculum all form part of the "sea change" that is needed.

Follow-up activities to Jomtien have already begun and will continue throughout the world. Non-governmental organisations of many kinds are involved. Associations for science and technology education must be particularly vigilant in ensuring that their voice is heard and that their members are actively involved in the sweeping changes in education which, hopefully, will follow the implementation of the Jomtien Declaration.

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Wanted: Acid Rain Partners For Project TARP-IT
by Michael Demchik

The co-directors of Project TARP-IT (The Acid Rain Project - International Twinning), Dr Michael J Demchik, Chemistry-Physics teacher, Jefferson High School, West Virginia and Dr Neil McKenzie of Nottingham Polytechnic, UK, are currently looking for further schools to participate in a month-long acid rain investigation. The earliest start is likely to be April or May this year with follow-up in October or November.

We have run three acid rain programs since 1988 involving schools in New Jersey, West Virginia, Florida and UK with excellent exchanges of information between participating students. This year we propose a two pronged strategy. In the first stage, students collect acid rain for one month according to an agreed methodology which we have tested in previous programs. Guidelines will be provided to help achieve common standards and methodology. In the second stage schools will pursue an extended investigation of the effects of different patterns of acid precipitation on plant growth. The rain data obtained in the first stage will be used to produce lab simulations of a range of climates under which the growth of wheat can be studied. In this way, the importance of acid rain on cereal production can be explored. Schools can participate in one or both stages. We expect to work
at two levels. Level 1 is for junior high/middle school students typically aged 12-14 years. Level 2 is aimed at 15-18 year old high school students. The benefits of Project TARP-IT are many, for example: multiple packets of data received from schools thousands of miles apart; valuable experience of collaboration in an international scientific research project; increased competence in carrying out reliable extended experimental research.

Interested teachers in the USA may contact Michael Demchik, Box 1420, Shepherdstown, West Virginia 25443, Tel. 304-267-9736 (home), Tel. 304-725-8491 (school). Teachers in the UK may contact Neil McKenzie, Department of Chemistry and Physics, Nottingham Polytechnic, Clifton Lane, Nottingham NG11 8NS, Tel. 0602-418418, extension 3184.

Annual Science for Educators Seminar

18-20 April 1991

Educators visiting Canada from member associations of ICASE are invited to participate in this annual seminar program which is spread over three days at the Chalk River Nuclear Laboratories in Ontario, Canada. While some sessions focus on nuclear reactor technology, including the Canadian CANU reactor, most sessions relate to areas that are at the basis of many different science and technology activities of our day.

On Day 1, teachers are given the opportunity to share an afternoon with a researcher. Here, teachers enter a laboratory, often on a one-to-one basis, and learn first hand what research is all about, and the personal views of the researchers and what motivates them. Teachers are able to select the disciplines of their choice, subject to space restrictions. The program on Days 2 and 3 consists of opening and closing plenary sessions, lectures and laboratory visits. This year’s seminar features sessions on fusion, new types of fission reactors, nuclear waste, corrosion, an environmental field trip, cancer and health sciences research, basic condensed matter and nuclear physics, glassblowing for science research, accelerators for both basic science and industrial use, and many others. The seminar is aimed at all educators - not just science teachers. AECL Research believes that it is important for all educators to become acquainted with current science and technology issues at the grass roots level. Teachers travelling to Canada and interested in participating in this seminar, are invited to write to Dr Malcolm Harvey, Director of Physics, AECL Research, Chalk River Laboratories, Chalk River Ontario, Canada K0J 1J0, Fax (613) 584-4024. Visitors are of course subject to security scrutiny associated with access to a Canadian nuclear laboratory.
The Harare Generator
University of Zimbabwe
21 January - 2 February 1991

by Sue Dale Tunnicliffe
Member of the Resource Team

The Harare Generator, a major initiative of the Committee on Teaching Science of the International Council of Scientific Unions (ICSU-CTS), was planned as a follow-on to the successful Bangalore Conference on "Science and Technology Education and Future Human Needs" which involved over 300 participants from all regions of the world and which examined ways in which science and technology education can be made more relevant to the needs of society in eight areas of concern. Although the books published as a result of the Bangalore Conference had made a major contribution to shaping science education, many felt that there was a need to directly involve teachers in applying the contents to local teaching situations. The Harare Generator was planned as an event to actively involve teachers and teacher educators in the production of tangible products.

Keynote presentations included: What was the Bangalore Conference?; Low Cost Equipment; The School Technology Movement; Audiovisual Techniques; Preparing Project Proposals.

A series of Sundown Seminars, to which local teachers were also invited, included: The microcomputer in education; Developments in primary school science; Science and technology in society; Popular science publishing; and Science education beyond the classroom.

Menu sessions provided yet another feature of the Generator, where Sundown Seminar speakers and Parallel Study Group leaders presented a synopsis of their sessions in order to help participants select the Project Planning Group or Parallel Study Group they wished to attend.

Project Planning Groups included: (1) Think and do, primary science; (2) Low cost practical exams; (3) Tree planting day; (4) Low cost electronics; (5) Microcomputer lab; (6) Computer simulations; (7) University/school liaison; (8) Aerial photography; (9) Discussion techniques; (10) The great egg race; (11) Expeditions; (12) Problem solving and decision making; (13) Games; (14) Using case studies; (15) Collecting and interpreting data; (16) Global laboratory; (17) School technology; and (18) Popular publishing.

A number of resource people from African countries, UK and USA were invited to assist with these Project Planning Groups. Each participant selected two Project Planning Groups, analysed the ideas presented by the speakers, and adapted them to the African teaching situation. They planned a program of work which was trialled with children in a school. The second phase of the generator was to produce teaching materials, and to script a short video of their school presentation so that this could be used throughout Africa. Resource people were encouraged to leave their groups so that the end product was the participants' work and not that of the resource people.

As the Generator came to an end, groups were suggesting possible sources of funding to enable further action to develop. For example, the primary science group proposed that a primary science newsletter, similar to *Fied Crow* in Kenya, be produced for teachers and children in cartoon strip form. This could be the African link with the ICASE Stepping into Science Project.

For further information about the Harare Generator and its outcomes, write to:

Mike Robson, Harare Generator Organising Committee, Faculty of Science, University of Zimbabwe, Box MP167, Harare, Zimbabwe

RSC Celebrates 150th Year

ICASE congratulates the Royal Society of Chemistry, UK on the occasion of its 150th anniversary. Today, the Society is active in a wide range of educational activities, for example:

The RSC produces a variety of careers information literature aimed at pupils from the age of 13 upwards.

The Society administers financial support to Chemistry Teachers Centres or to individual chemistry teachers who have specific projects they want to get started.

*Education in Chemistry* is the only journal which covers chemical education from secondary schools to universities. It provides a forum for school curriculum discussions.

By subscription to the Schools Publication Service, schools receive quality resource material generated from around the world and relevant to the teaching of chemistry. In addition to *Education in Chemistry*, it includes *Chemistry in Action* from Ireland, *Chem matters* from the USA, and *Chem 13 News* from Canada.

The RSC runs a number of awareness raising, one day symposia, focusing on topical issues relating to the teaching of chemistry in schools.

The Society's successful Industry Study Tours bring industrialists and educationalists together. Over a short residential period, teachers see chemical processes in action and are able to discuss the nature of industrial problems with those employed in the field. Teachers often produce curriculum materials suitable for use in the classroom.

The RSC hosts Chemistry Project Weeks, which bring together sixth form chemistry students, their teachers, higher education lecturers and industrial scientists, enabling students to tackle real industrial problems.

For more information on these and other projects, contact Dr A D Ashmore, Education Department, The Royal Society of Chemistry, Burlington House, Piccadilly, London W1V 0BN, UK
The Power of Cooperative Learning

by Alan Colburn & John E Penick

"Where's the teacher?" asks the school's secretary as she enters the classroom. She had instinctively looked to the front of the room.

"Over there," says a student pointing to the teacher in the midst of a group of four students. The secretary sees other small clusters of students dispersed throughout the room. Students are talking quietly, some tutoring each other, while others are working out a presentation strategy. Almost everyone seems to be purposefully involved in something.

In this type of classroom - the cooperatively structured classroom - small groups of students work together toward a common goal. The cooperative classroom offers distinct contrasts with the common competitive and individually structured classrooms. In contrast, in a competitively structured classroom, students are working against one another. One student can only "win" if another "loses". The individually structured classroom features students working by themselves - independent of what happens to their classmates.

All three provide effective teaching, but cooperative learning offers several unique advantages.

Cooperative learning represents powerful classroom instructional strategies that are defensible from both philosophical and extensive research bases. Indeed, humans have survived this long because of our ability to cooperate for the good of the group. Johnson et al (1984) point out that:

"At a time when being able to interact effectively with other people is so vital in marriages, in families, on jobs, and in committees, schools insist that students don't talk to each other, don't work together, don't pay attention to or care about the work of other students - students are encouraged not to care about other students' learning in the classroom." (p 7)

Learning in cooperative small groups builds constructive relationships, overcomes prejudices, and prevents behaviours like delinquency and drug abuse. Cooperative learning builds positive relationships between difficult children and others with more constructive behaviours.

However, cooperative learning is not merely students working in groups. The essential feature of cooperative learning is that the success of one student helps other students to be successful (Slavin, 1987).

In a cooperative learning group, students are concerned about the performance of all the group members. At the same time, students are held individually accountable for their learning and given feedback on their performance. This helps other group members know who to help and encourage.

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![Figure 1](attachment:image.png)

**Figure 1**

**Characteristics of Cooperative and Traditional Learning Groups**

<table>
<thead>
<tr>
<th>Cooperative Learning Groups</th>
<th>Traditional Learning Groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive interdependence</td>
<td>No interdependence</td>
</tr>
<tr>
<td>Individual accountability</td>
<td>No individual accountability</td>
</tr>
<tr>
<td>Heterogeneous</td>
<td>Homogeneous</td>
</tr>
<tr>
<td>Shared leadership</td>
<td>One appointed leader</td>
</tr>
<tr>
<td>Shared responsibility for each other</td>
<td>Responsibility only for self</td>
</tr>
<tr>
<td>Task and group maintenance emphasised</td>
<td>Only task emphasised</td>
</tr>
<tr>
<td>Social skills directly taught</td>
<td>Social skills assumed and ignored</td>
</tr>
<tr>
<td>Teacher observes and intervenes</td>
<td>Teacher ignores group functioning</td>
</tr>
<tr>
<td>Groups process their effectiveness</td>
<td>No group processing</td>
</tr>
</tbody>
</table>
These two features of cooperative learning groups, positive interdependence among members and individual accountability, contrasts with more traditional learning groups in which there is no interdependence, individual accountability, or incentive for students to work together (see Figure 1).

Aronson’s (1978) Jigsaw method provides one example of a cooperatively structured classroom. Students in a biology class are assigned to three member teams to learn about digestion. The academic material has been broken down into sections about digestion of proteins, carbohydrates, and lipids—each team member is responsible for learning only one section. Next, members of different teams who studied the same topic (e.g., protein digestion), meet in ‘expert groups’ to discuss their section. Then the students return to their original teams and teach their teammates about their section. The only way students can learn about sections other than their own, is to work with their teammates. Later, all of the students will have to demonstrate their knowledge of digestion via a teacher-generated quiz, a practical examination, or project work. Although every student’s individual scores are recorded, each member of a team can receive extra-credit ‘bonus’ points if the group’s average score is above 85%.

Notice that the students are dependent upon one another. This is a hallmark of real cooperative learning. At the same time, each student is still held accountable for all of the requisite learning. Additionally, the teacher’s role would include not only helping students learn about digestion, but how to teach others while helping the students develop social skills for working together.

Research about cooperative learning and academic achievement

Slavin (1987) summarises the results of 63 studies on the achievement effects of cooperative learning. Fifty seven percent of the studies found significantly greater achievement for cooperative groups over control groups; 41% found no differences. Johnson et al’s 1984 meta-analyses of 122 studies showed that cooperatively structured learning experiences promote higher student achievement than other ways of classroom structuring.

To produce increased achievement there should be some sort of group reward such as recognition, extra credit or certificates (Good & Brophy, 1987). Slavin (1987) suggests that when the group’s job is to be sure that every group member has learned something, it is in the interest of every member to spend time explaining concepts to other group members.

He points out that other studies have consistently found that the students who gain the most from cooperative work are those who give and receive the most elaborate explanations.

Good & Brophy (1987) mention the importance of methods that ensure individual accountability of group members. No study in which group members work together solely to produce a single worksheet or group product has yielded positive achievement affects.

In these situations, there is little incentive for the more able group members to explain things or to ask the opinions of the less able members, or for less able members to seek assistance.

In a study of specific factors that contribute most to successful implementation of cooperative learning strategies, Prescott (1990) found that elementary teachers selected ‘reward system’ more than any other factor. Among secondary teachers, only ‘teaching/management skills’ was selected more often.

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Contact Dr Jack Holbrook, Executive Secretary ICASE
Royal Society of Chemistry, Burlington House, Piccadilly, London W1V 0BN, UK
Research about cooperative learning and social skills
People who cooperate learn to like each other. This conclusion holds true for students with different ethnic backgrounds, ability levels, social class differences and in mainstreamed classrooms (children with physical or mental handicaps in "regular" classrooms). (Slavin, 1987)

Because students benefit from helping each other, they assist and encourage more in cooperative groups than in competitive or individually structured classrooms. Cooperative learning experiences also promote stronger beliefs that a student is accepted by others. These experiences increase the ability to understand how a situation appears to another person and how that person is reacting to the situation. Not surprisingly then, cooperative learning experiences tend to decrease negative stereotypical views among students (Johnson et al, 1984).

Several researchers have found that cooperative group work may increase student's self-esteem. Students in cooperative groups tend to have more positive feelings about themselves; they like others and feel liked by others more often than those in control groups. They may also feel more successful in their school work, which could also contribute to increased self-esteem (Salvin, 1987).

Johnson et al (1984) also point to evidence that students working together in cooperative learning groups develop better collaborative skills than students in other types of classrooms; are more motivated with better attitudes toward a subject; and are more likely to grow in the use of higher order thinking skills. And, while not researched yet, logic would suggest that students who study science together - discussing, arguing, debating, and explaining - would learn more of the processes, applications and true nature of science.

Some final thoughts
We all want our students to be more cooperative, more accepting of others, and to feel better about themselves. But, we also want them to learn the content, processes, and nature of their subject. Here is where cooperatively structured classrooms are at their best. Students learn as much or more content as in more traditional classes and, as an added benefit, they develop powerful social skills and attitudes necessary for successful adult life.

Only one real question remains - why aren't all classes structured for cooperative learning? The next issue will focus on tips for implementing a cooperative class.

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Science Teacher Education

Some Recommended Ways for Including Multicultural Education in a Preservice Science Methods Course

George E. O'Brien

An important component of preservice elementary teacher preparation programs which is often ignored by science educators, is multicultural education. The US National Council for Accreditation of Teacher Education (NCATE), which has high standards for multicultural education, has defined multicultural education as:

The preparation of the social, political, and economic realities that individuals experience in culturally diverse and complex human encounters. This preparation provides a process by which an individual develops competencies for perceiving, believing, evaluating and behaving in different cultural settings. (NCTA, 1980)

Encouraging preservice teachers to develop realistic perspectives of cultural diversity, women's concerns, the rights of children, and issues important to other groups in society, should be a function of the entire elementary program's curriculum and instruction. Therefore, instructors of science methods' courses should contribute to the preservice teacher's overall development in multicultural education.

Atwater (1989) has identified a list of multicultural competencies which teachers of science should possess. These competencies are:

1. Create a classroom environment and help create a school environment representing a multicultural approach to education.
2. Develop science curricula and curriculum materials, and teach science lessons appropriate to the students, taking into account the cultural diversity of the students.
3. Detect biases and deficiencies in commercial and teacher-made curriculum materials.

This section focuses on the pre-service and in-service education of science teachers, and aims to communicate ideas and strategies which will assist science teacher educators to enhance and enrich their pre-service and in-service programs.

4. Assess inclusion models that are relevant and feasible for ethnic minority groups to use in classrooms and schools.
5. Show a basic knowledge of the contributions of minority groups to society, especially in science and technology.
6. Perceive linguistic and cultural biases in assessment and evaluative instruments, and in the prescription of a testing program.
7. Develop a philosophy on bilingual education when necessary.
8. Possess a knowledge of the cultural experience in both a contemporary and historical setting of any two ethnic, racial, or cultural groups.

This list of competencies is helpful to instructors creating and selecting activities for multicultural education in a preservice science methods course.

There are numerous opportunities and ways that a science methods course might be structured to help focus on stereotyping, racism, classroom environment, and characteristics of a multicultural science teacher. The following description of ways to incorporate multicultural education in a science methods course more specifically addresses competencies 1 to 4 listed above. I have found the following instructional strategies, activities, and assignments valuable in helping preservice teachers develop these multicultural competencies.

IN-CLASS WORK AND ASSIGNMENTS

1. Competencies and course objectives

Instructors should state course goals, objectives, and required competencies in relation to multicultural education in the course overview and syllabus, not present them as an afterthought, or in an inconspicuous manner.

2. The role of the instructor - the teacher as a model

The first and possibly most obvious place to start instruction of multicultural educational concepts in a methods course is by modelling appropriate behaviour and language in the classroom. Tiedt and Tiedt (1989) have pointed out that instructors can show preservice teachers how to (1) use language that is free of racist and sexist terms or labels; (2) recognise careless use of language and stereotyped perceptions of people that can hurt human beings and limit their potential; and (3) talk about people as individual human beings who have varied characteristics not limited by sex, race, class, or ethnic background.

Every instructor can lead preservice teachers to greater awareness by (1) modelling appropriate behaviour and usage of language; (2) initiating discussion of questionable practices and uses of language; (3) planning lessons designed to break down stereotyped thinking; and (4) selecting non-stereotyped text materials.
3. Make available excellent classroom materials
In addition to evaluating course texts and materials for appropriateness in a multicultural context, instructors should make available to preservice teachers samples of excellent science textbooks and associated resource materials, children's trade books, games, and audiovisual materials. These will serve the purpose of allowing preservice teachers the opportunities of comparisons with school resources during science teaching practice.

4. Local teacher with expertise
Invite a local teacher with expertise in multicultural education to share philosophy, practical teaching tips, and relevant experiences of teaching science. Arrange to videotape such an expert in various teaching environments and have the preservice teachers utilise the videotapes for analyses of instructional behaviours when studying topics including management, language, exceptional needs, school environment, and cooperative learning.

5. Small group discussions - share feelings, experiences
Arrange for small group discussions at least 3 to 4 times during the semester so that preservice teachers might share personal feelings and experiences, science teaching practice observations and comparisons of exemplary models of curriculum and instruction versus poor models. Arrange these sessions at strategic points in the curriculum. Good times might be immediately after certain preservice teachers' activities (that is, interviews of cooperating teachers and school administrators, observations of cooperating teachers, evaluations of school science materials) and during the time immediately preceding the preparation of learning/inquiry centres.

SCIENCE TEACHING PRACTICE WORK AND ASSIGNMENTS
Concurrent with the work in the science methods classroom, preservice teachers should be given several science teaching practice assignments that include components of multicultural education. These assignments, which are consistently evaluated highly by the preservice teachers, provide the preservice teachers with opportunities to enhance understanding of concepts and develop instructional skills.

1. Interviews
Have the preservice teachers discover as much as possible about the science program and science curricula at the practica schools by scheduling interviews with key personnel including the cooperating teachers, assistant principal and principal. Have them include in their inquiries questions focusing on elements in multicultural education.

2. Evaluating resources available in schools
Have the preservice teachers analyse student textbooks and any other print and nonprint materials for multicultural education content.

3. Observations of cooperating teachers and students
Have preservice teachers include criteria for multicultural education in their analyses of observations of science lessons.

4. Lesson plans
Include in the lesson plan format a category for multicultural education in addition to traditional categories such as instructional objectives, materials, induction, transition, sequence of activities, closure, evaluation of students, and lesson analysis.

5. Teaching lessons
Have the preservice teacher plan, prepare, and teach two or more lessons which include instructional strategies for multicultural education. Lessons should be audiotaped or videotaped.

6. Lesson evaluation
Have the preservice teachers self-evaluate and write critiques of instructional performances including analyses of instructional strategies involving skills and concepts in multicultural education.

7. Developing and implementing learning inquiry centres
Have the preservice teachers develop and implement learning inquiry centres that focus upon cultural and science aspects.

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SUPPORTING SCIENCE IN SCHOOLS

IDEAS, ACTIVITIES AND RESOURCES FOR PROFESSIONAL DEVELOPMENT

By Stuart Naylor & Alan McMurdro

"Those that can, do; those that can't, teach. Those that can't teach, teach teachers."

Few teachers would agree with the first part of this statement, even if some of the leader writers in the newspapers prefer to believe it. Those who make the claim are often speaking from a position of ignorance, with little knowledge of the realities of classroom life or of the range of skills needed to survive for more than 10 minutes in the classroom.

As well as teaching children many teachers now also have a responsibility for teaching teachers, by providing professional development opportunities for their colleagues. Why is it then that teachers who are quick to defend the learning opportunities offered to children, will often be critical of much of what is offered by their colleagues for their own professional development?

Perhaps we should not be surprised. Teachers who are asked to put on an inservice day for their colleagues will generally have no extra preparation time; they may have had little previous experience as INSET providers; and they will probably have few resources to support them. When providing learning opportunities for teachers is at least as demanding as providing them for children, it is not surprising that so many teachers have often been dissatisfied with school-based inservice.

Supporting Science in Schools breaks new ground in providing useful ideas, suitable activities and appropriate resources for school-based professional development. The photocopiable loose-leaf format makes this publication very user-friendly. Structured activities, role plays, simulations and workshops can be used off the shelf, with very little advance preparation. Briefings for organisers (covering timing, groupings, taking feedback, etc) provide all the details needed for getting it right.

Wherever possible the activities take everyday situations as their starting point, rather than starting with general principles which may not always seem immediately relevant. Another unique feature is the way that it is designed for primary and secondary classroom teachers as well as for teacher educators. Even for experienced INSET providers, this pack provides a set of ideas and resources which offer fresh perspectives on familiar situations and some insights into unfamiliar areas. The structure also provides for departmental or whole school development which goes far beyond science. Any school will find that having their own copy is highly cost effective.

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Visits to animal collections can be interactive in a number of ways. Silvia Wirth-Hirch, Education Officer at Alpenzoo in Austria, has developed interactive programs for children of 8 years upwards. Here she shares an account of behaviour studies carried out by pupils.

Humans are very tactile - we like to get an impression of things by feeling their surface, their temperature, etc. The German word "begreifen", which means "to comprehend by touching", represents one educational method by which we can learn about animals in a zoo. However, it is not appropriate to use this method with all animals; hence I have changed the methods of the educational programs at Alpenzoo by using three other senses - hearing, smelling and seeing; and I have stopped describing the life and needs of the animals - it is now up to the students to discover these things about the animals.

With pupils, the following behavioural study methods can be used - they are no different from those taught at university level: (1) Qualitative behaviour descriptions to compare the same behaviour pattern in different age groups or individual animals; (2) Quantitative behaviour descriptions such as scan sampling, sequence sampling, sampling occurrences of some behaviours and the nearest neighbour method.

With younger children, data sheets need to be simplified, and the tasks of observing and recording shared. Older children, after an explanation, will be able to design their own data sheets and manage the tasks of both observing and recording.

These are some examples of behavioural studies carried out at Alpenzoo.

Birds provide an excellent opportunity for observing habitat-specific behaviour. The aviary for small birds at Alpenzoo is structured so that birds can change compartments. Each compartment has a different plant growth. With a data sheet divided into columns with headings Conifers, Deciduous Trees, Wall, Fence, and Floor, pupils can find out which plant or structure is preferred by various bird species.

Using a second table with columns headed Flying, Climbing, Going, Jumping, and Other Locomotions, pupils can find out the mode of locomotion used by different bird species.

Because small birds are very active, pupils have sufficient data after 20 minutes of observation, to attempt a description of the habitat for each bird species.

A further activity involves studying food choice and feeding strategies for different species. For example, the nutcracker feeds on the seeds of a pine species, Pinus cembra. Mainly in autumn, the nutcracker collects these seeds, transports them in its throat and hides them in order to have a food reserve during winter. If there are insufficient pine seeds, the bird comes down into the valleys and collects hazelnuts, walnuts, beechnuts and acorns. With a simple data sheet with columns headed Pinus Seed, Walnut, and Hazelnut, young children can easily collect data about the food choice of the nutcracker. Older children can use a more complex data sheet with additional columns to record the feeding strategy, noting duration, place, and feeding, picking, hiding behaviours.

Here is a description of how pupils can investigate social hierarchy, dominance and space utilisation, using a simple scanning method. The first step involves each pupil sketching the layout of an enclosure. While one
student acts as a timer by calling out "now" every 30 seconds, each pupil notes on the sketch where his/her assigned animal is at that moment. After 30 minutes, students have sufficient data to determine which part of the enclosure is most used by the animals. Normally, higher ranking animals are near important places such as food boxes and viewing points; lower ranking animals are relegated to the periphery of the enclosure. This method is not reliable during mating season or at other times when normal behaviour patterns are disturbed.

Other examples of animal behaviour studies at Alpenzoo include:

- Interaction between brown bears during mating season
- Interaction between two species within the one enclosure
- Contact between mother and young
- Playing behaviour
- Which is the dominant species at the duck pond?

These programs aim to interest pupils in nature without the need to touch or to manipulate; they generate an excitement as pupils become nature detectives, finding out what they can about nature - the strategies, the adaptations, the behaviour patterns - and they instil a respect for the gigantic network of nature as they interact with their minds, instead of with their hands.

Stepping into Science Newsletter
Teachers actively involved in Stepping into Science are planning to compile and distribute a newsletter containing ideas to try and other information about Stepping into Science. If you would like to contribute, or have your name added to the distribution list, contact:

Sue Dale Tunnicliffe, Education Department
Zoological Society, Regent's Park
London NW1 4RY, UK
Tel 44-71-722-3333, Fax 44-71-483-4436

Making Music
An activity with straws
Based on CESI File Sheet #17

The materials for this activity are simple - drinking straws and scissors!

The goal of this activity is to investigate the sound-producing capabilities of drinking straws.

Start by cutting one end of a straw like this:

Then place it in your mouth and blow. Experiment until you get the correct placement of the straw between your lips and teeth.

How can you vary the sound? Try changing the shape of the point. Try changing the length of the straw.

Science Activities Re-Using Used Materials
These ideas for making a wind-vane or wind-powered rotor appeared in Investigating, the Australian Primary Science Journal Vol 6 No 3 August 1990

Illustrations of wind vanes by Charlotte Pocock
Greenhouse Teaching Resources

STS (Science Technology Society) courses have different aims and include topics which are different to those of traditional science courses. New aims and topics, however, are insufficient by themselves to bring about desirable changes in schools. If we are to motivate all of our students and help them to develop genuine understanding and relevant attitudes about science, technology and society, we also need to change our teaching approaches. Many teachers accept this need and are actively seeking and trying out new ideas for better learning and teaching.

An excellent "Greenhouse Education Kit" produced in South Australia contains more than 30 activity sheets suggesting a wide range of activities (refer to Figure 1).

Many of these activities are of a kind which I shall call "non-traditional" because they are not frequently used by science teachers. The importance of combining such non-traditional activities with traditional ones to produce a more meaningful program for students has been discussed in a number of publications. A book edited by Bentley and Watts (1989) and another by Gianello (1988) are particularly valuable for science teachers because they include many practical suggestions, case studies and examples to help teachers explore new ways of teaching.

Gianello (1988) also emphasises the importance of non-traditional activities in science courses to encourage girls as well as boys in science.

The Greenhouse Education Kit has been produced by the Energy Information Centre and the South Australian Energy Forum. The materials are flexible to use. They have been written for students in Years 6-9, but can be modified by teachers for use at other levels in elementary and secondary schools. Four worksheets have been reproduced on the following pages.

As well as worksheets, the kit contains information sheets that are basic and easy to follow. Additional information, where necessary, would need to be obtained from other sources such as newspapers, libraries and government departments.

Further information about the kit can be obtained from:

Dr Jill Kerby
The South Australian Energy Forum
Level 19, 30 Wakefield Street
Adelaide SA 5000, Australia

References
Gianello, L (1988) Getting into gear: Gender inclusive teaching strategies in science Canberra: Curriculum Development Centre
WRITING LETTERS

This activity introduces letter writing as a form of social action to increase public awareness of environmental risks.

REQUIREMENTS:
Pencil or pen, paper for each student
Examples of letters written to a newspaper

PROCESS:
Find and read some examples of letters written to a newspaper.
Select an issue related to climate change.
Decide the type of reader to whom the letter is addressed.
Write a brief letter of no more than 100 words about the issue. The letter should include the following points:

- who you are and what your position is e.g. student
- what you are writing about
- why it concerns you
- what will be the consequences if no changes are made
- what should be done
- who should do it
- what benefits will be gained from the changes

Share your letter with others in the class and display it on a greenhouse notice board (See Activity Sheet 1).

DISCUSSION:
Why should your letter be brief?
What kinds of people write letters to newspapers?
Who is likely to read newspaper letters?
Are newspaper letters effective in changing attitudes?
Can you identify some other people, industries or organisations to whom letters could be written?
SUPERMARKET SURVEY

In this activity you can examine a range of goods sold in supermarkets or stores which may be contributing to climate change. Make sure that you obtain prior approval from the store concerned if this activity is to be done by school group visits. Alternatives to school group visits could be individuals collecting data while shopping with parents, or working in class from advertising brochures and catalogues.

REQUIREMENTS:
Pencil or pen and paper for each group
Survey record sheets, made up by students
Advertising brochures, or access to a supermarket

PROCESS:
Work in small groups of up to four students.
Prepare a survey sheet with the following columns:
Product Name, Product Use, Cost, Type of Packaging,
Environmental Effects, Necessity, Alternatives.
Examine as many products as you have time for, and fill in on the survey sheet the first four columns as you go.
Back at School discuss with others in the group what should go into columns 5, 6, 7 for each product.
Share your survey findings with others in the class.

DISCUSSION:
Which products are likely to harm the environment?
Which products are unnecessary?
Why are there so many choices?
How much packaging is necessary?
How does advertising affect sales?
How does advertising affect the environment?
Plan a campaign to educate the public about the effects on the environment of having such a large range of consumer products.
Identify some areas in which you could reduce your personal consumption of such products.
THE GREENHOUSE GAME

In this activity you make up your own board game about greenhouse and play it. At the same time you will be learning about some of the factors affecting our earth.

REQUIREMENTS:
Large sheet of cardboard or paper per group
Cardboard to make game cards
Glue, scissors and coloured pencils
Counters and dice to play

PROCESS:
Mark out the board with squares (as many as you like, up to 100).
Make up a set of cards with positive and negative statements about the environment (the more cards the better).
For example: "You were driven to school today because you didn’t feel like walking. GO BACK 3 SQUARES".
"At home you sort your rubbish into groups for recycling. GO FORWARD 4 SQUARES."
Illustrate the cards.
Illustrate and decorate your board.
Play your board game to see if it works well, then make any improvements, e.g. more squares, more cards, different penalties.

DISCUSSION:
Play another group’s board game and tell them what you like about their game.
Do you think games like this are an effective way of getting the greenhouse message across?
Can you adopt your game so it can be played in the schoolyard, with squares marked out and using giant dice (cardboard box) and people as counters?
MELTING ICE

This activity examines the way in which a greenhouse alters the rate at which ice melts.

REQUIREMENTS:
2 ice cubes per group
1 large glass or jar per group

PROCESS:
Place the two ice cubes near one another on a tray or somewhere that water won’t cause damage.
Place the glass upside down over one ice cube.
Observe over a period of time. Try some pairs of cubes in full sunlight, others in shaded areas and others inside.

DISCUSSION:
Which ice cube melted first in each case?
Were there any water droplets on the inside of the jar?
Where did they come from?
NEW ICASE PUBLICATION

Empirical Research
in Mathematics and Science Education

Proceedings of the International Seminar
6-8 June 1990
University of Dortmund, Germany

The proceedings (221 pages) includes the following papers: Using an expert system to analyse students’ ability to process information in the area of basic electricity, Christoph von Rhöneck; Commonsense understandings of causes of motion, Denise Whitelock; Assessment of performance unit: a longitudinal study of science performance at ages 12 and 14 in the UK, Martin Braund; A label as hidden persuader: chemists’ neutralisation concept, Hans-Jürgen Schmidt; Student’s understanding of the particle nature of matter and its relation to problem solving, Dorothy L Gabel; Towards a more effective methodology of research on teaching and learning chemical equations, Onno de Jong; Learning, hierarchies in mathematics: a critique, Elisabeth Sander; Introduction to the study of interdependence between selected traits and the use of the question-answer technique in problem solving, Matthias Ehrsam; On the methodology of the investigation of the pupils’ structures of knowledge, acquired in the lessons of chemistry, Rolf Lämmer; Concept learning in biology teaching, Dittmar Graf; Two decades of research in science education: an American perspective, Anne C Howe; and other articles.

Copies, at a cost of US$8.75 including postage, can be ordered from:
Dennis Chisman, Honorary Treasurer, ICASE
Knapp Hill, South Harting, Petersfield GU31 5LJ, UK

Most articles discuss the use of the computer in conjunction with experiments - not only for on-line data acquisition, but also for simulating or modelling phenomena. This is an educational strategy advocated by AIF, for example:
The article dealing with simulations describes instructional strategies to be used in conjunction with laboratory activities, to increase students' comprehension of phenomenological aspects before arriving at a formal description.

Two approaches are apparent in articles describing actual classroom experiences. The first approach goes from the experiment to the construction of a computer model (usually a dynamic type) in which the experimental pattern is reproduced and recognised. The second goes from studying a typical mathematical function to performing experiments on phenomena exhibiting the same behaviour (for example, capacitors during an electric transient in connection with the differential equation leading to exponential behaviour). The issue is published in Italian, and is available at a cost of Lit 10000.

Another AIF special issue on the didactics of physics is Teaching the Second Law of Thermodynamics in the School Vol XXII No 2, 160 pages, Lit 10000. The issue contains materials produced by an AIF inservice course for teachers. This issue is also published in Italian. Address your request for these issues and prepayment in Italian lira to:
Dr Marisa Michelin
Editor, La Fisica nella Scuola
Dipartimento di Fisica della Scuola
Dipartimento di Fisica della Scuola
Dipartimento di Fisica della Scuola
41100 Modena, Italy
The Teaching of Science and Technology in an Interdisciplinary Context
Vol II
Unesco, Paris 1990

This publication, No 38 in the Unesco Science and Technology Education Document Series, is a summary of the Pilot Project and Proceedings of the Concluding Consultation held in Plovdiv, Bulgaria, 25-29 May 1987.

The Pilot Project on the Teaching of Science and Technology in an Interdisciplinary Context was part of a series of 10 pilot projects on various aspects of the teaching of science and technology at the primary and secondary school levels undertaken by Unesco's Division of Science, Technical and Environmental Education in a total of approximately 50 countries from 1981 through 1987.

The objectives of the Pilot Project on the Teaching of Science and Technology in an Interdisciplinary Context were to develop and test ways in which the concepts, processes and skills of science and technology could be linked with or incorporated into the teaching of other areas in the school curriculum at both the primary and secondary school levels.

Emphasis was placed on teaching methods and activities that promote understanding through active learning techniques, on efforts to link classroom learning with real-life experiences and on extending this teaching beyond the classroom.

The project, launched in 1984 and completed in 1987, had two aspects - one concerned with education in the basic sciences and mathematics, the other with nutrition and health education.

Five countries were officially involved in the project - Bulgaria, Denmark and the United Kingdom for the first aspect, Thailand and Indonesia for the second; other countries which became involved unofficially before the conclusion of the project were Germany, Norway, Sweden, USSR and USA. The official conclusion of the project was the consultation held in Bulgaria, the proceedings of which constitute this document, edited by Harold Foecke.

The contents include: Objectives and achievements of the pilot project, Harold A Foecke; The pilot project and the consultation in perspective, Sheila M Haggis; and a number of papers by attendees from countries participating in the pilot project.

Papers include: Teaching science in an interdisciplinary context: the Scottish experience, Sinclair MacLeod; Bees and their mathematics: a project integrating math and science, Otto B Bekken; The primary science project in Norway, Doris Jorde; The school and healthier living, Soetirso Kusumohadi; Why teach science in primary schools? Helene Srenson; Man, nature and polarised light, Erik W Thulstrup; Project work in environmental protection in the natural science branch of the upper secondary school in Sweden, Aina Tullberg; Project work in chemistry and scientific writing in the upper secondary school in Sweden, Aina Tullberg & Marianne Lindgren; The integrated course NATURE in the curricular structure of BARGE, D Lazarov & E Golovinsky; Applying informatics in science teaching: some examples, Polexenia Sarkissyan & Evgenia Sendova.

Papers by attendees from other countries include: Dimensions of integration, Donna F Berlin; Computer simulations in science teaching: aspects of didactics and software ergonomics, Peter Gorny; Consequences of the history of science in regard to the learning process in science education, von Alfrid Gramm; Computer-assisted learning (CAL) in science, Alison Rose; A basis for a triple integration: language-mathematics-informatics, A.L. Semonov.

Basic Concepts in Scientific Research
by Y Friedler & P Tamir
The Amos De-Shalit Science Teaching Centre, Israel

Evaluation studies all over the world have shown that for many students the laboratory experiences in school are not meaningful and learning by inquiry has failed to achieve its aims. We have developed a module entitled Basic Concepts of Scientific Research (BCSR) which has been successfully used in Israel from Grade 9 up to teacher education levels. The English version of BCSR has just been published. The materials cover:

- Historical introduction
- The research problem
- The research hypothesis
- Deduction: a stage in testing the hypothesis
- Designing the experiment
- The research process in its entirety
- An interesting story

The student text (68 pages) costs US$4.00 including postage. The teachers guide (27 pages) costs US$3.00 including postage.


Copies are available from:
The Israel Science Teaching Center
Hebrew University
Jerusalem
Israel

NOW AVAILABLE
Australian Chemistry Resource Book
1990 EDITION
Copies at a cost of A$10 may be ordered from
C L Fogliani
School of Applied Sciences
Charles Sturt University - Mitchell
Bathurst NSW 2795, Australia
ICASE is keen to arrange regional or world events for the benefit of member associations. If your association or organisation is interested in hosting an international seminar, workshop or conference, contact the Executive Secretary or your Regional Representative. To gain ICASE endorsement, the meeting must be international in nature, open to member associations, and, while all sectors of the science education community should be encouraged to participate, must be relevant to classroom teachers.

1991

March 27-30
NSTA National Convention
Location: Houston, Texas, USA
Contact: Linda Crow, Asst Professor, Baylor College of Medicine, One Baylor Plaza, Room 633E, Houston, Texas 77030, USA
International delegates are invited to participate in the Fourth International Round Table - just one of the many features of this convention which plans to cater for almost 20000 science educators, including a large number of science educators from other countries! Each country is provided one or more tables in a large room where delegates can display and present information on science education in their country.

March 29 - April 3
7th ICASE-Asian Symposium
Location: East China Normal University, Shanghai, China
Contact: Prof Mi Zhong, Department of Physics, East China Normal University, Shanghai 200062, China
The symposium will be conducted in English/Chinese and will address the theme Making science education in schools more relevant. The program will focus on (1) the development of appropriate curricula, the issue of integrated science vs separate sciences, the introduction of STS in science courses; (2) innovations in teaching, the role of project work, the teaching of science communication skills, low cost equipment, fieldwork; (3) technology in education, the effective use of visual aids, visits to industry, the place of the computer; and (4) research in science education, children’s learning in science, assessment techniques. The program will consist of presentations by internationally renown science educators; papers, workshop and discussion sessions; poster displays; and an exhibition. The second circular is available from the address above, and details arrangements concerning registration ($US50 for members of science teacher associations), accommodation, program, and the obtaining of visas to visit the Peoples Republic of China.

April 1-14
Edinburgh International Science Festival
Location: Edinburgh, Scotland, UK
Contact: Edinburgh Science Festival Ltd, 20 Torphichen Street, Edinburgh EH3 8JB, Scotland, UK
There is something of interest for everyone at the international science festival. Now in its third year, this lively celebration of all the sciences, from astronomy to zoology, is geared as much for those who are merely curious or concerned about the world as it is for the serious scientist. The 1991 festival will focus on the human body, but many other topics as diverse as wildlife and artificial intelligence, and biotechnology and electronics will be covered in an extensive program of demonstrations, debates, exhibitions, films, workshops, walks and talks. A full program is available from the contact above.

April 5-8
Chemistry and Developing Countries
Location: Imperial College, London, UK
Contact: Stanley S Langer, The Royal Society of Chemistry, Burlington House, Piccadilly, London W1V 0BN, UK
This conference will be the second organised by The Royal Society of Chemistry on the theme of chemistry and development. The 1991 conference, to be organised as part of the celebrations to mark the 150th Anniversary of the Society, will focus on two themes: (1) chemistry for the environment, and (2) organising science to benefit the third world. Representatives of several chemical associations from around the world will be invited to present their views of problems and opportunities.

April 15-17
CASTME Plenary Meeting and Conference
Location: Vancouver, British Columbia, Canada
Contact: Mrs V Salisbury, 42 Bluebell Road, Norwich NR4 7LG, UK
CASTME, the Commonwealth Association of Science Technology and Mathematics Educators, is holding this conference in conjunction with the Commonwealth of Learning. The themes of the meeting are Quality, Assessment and Distance Learning in Science Technology and Mathematics Education.
educators from North America and beyond. Throughout the weeklong conference, activities are planned for all members of the family including excursions, field trips, sports activities and social events - a feature of ChemEd conferences.

August 19-24
32nd Annual Conference of STAN
Location: Yola, Gongola State, Nigeria
Contact: Mr Ben B Akpan, National Secretariat, Government College Campus, PMB 5075, Ibadan, Nigeria
The Science Teachers Association of Nigeria invites you to participate in their 32nd Annual Conference. The theme of Teaching Science Technology and Mathematics in the Mother Tongue will include subthemes on philosophical implications, curricula implications, implications for the learner, and implications for the teacher.

August 25-30
11th International Conference on Chemical Education
Location: University of York, York, UK
Contact: Dr John F Gibson, ICCE 11, Royal Society of Chemistry, Burlington House, Piccadilly, London W1V 0BN, UK
This biennial conference on the theme Bringing Chemistry to Life is being organised by the IUPAC Committee on Teaching of Chemistry in conjunction with UNESCO and the Association for Science Education. The conference will focus on (1) making chemistry accessible to all students (2) new curricula at primary, secondary and post-secondary levels (3) new teaching strategies at all levels (4) teaching and learning at a distance (5) new frontiers of chemistry and their impact on teaching, and (6) research in chemical education. The program will include plenary lectures, poster papers, symposia, workshops, exhibitions, times for participants to discuss aspects of chemical education of special interest, social events and local visits. Responses to the first circular have been received from over 70 countries. The second circular and registration form is now available from the above address.

August 12-22
Sixth International Symposium of IOSTE
Location: Wyndham Palm Springs Hotel and Resort, Palm Springs, California, USA
Contact: Dr Herbert K Brunkhorst, Institute for Science Education, California State University, 5500 University Parkway, San Bernardino, California 92407-2397, USA
The theme of the 6th International Symposium on World Trends in Science and Technology Education is Science and Technology Education: Responsible Change for the 21st Century. Science and technology education will be related to responsible change with respect to the role of science educators, scientists, engineers, business/industry and government agencies in the global community. The symposium will provide a forum for dialogue to increase awareness of regional perspectives worldwide and develop closer cooperation in addressing mutual concerns. This dialogue will be held in the context of science education
issues, environmental issues, technology issues and socio-cultural issues. The symposium will be presented in English.

**August 26-30**

**Fourth Asian Chemical Congress**
Location: Beijing, China
Contact: Prof Dehe Zhang, Secretary General of AACC, Chinese Chemical Society, PO Box 2709, Beijing 100080, China
The 4th Asian Chemical Congress will be held under the sponsorship of the Federation of Asian Chemical Societies. The Congress will focus on the important role of chemistry in raising the health conditions and living standards for all people. The program of plenary lectures, invited papers and contributed papers will be conducted in English and will concern various topics including organic chemistry of natural products, analytical chemistry and instrumentation, environmental chemistry, agrochemistry, coordination chemistry and its applications in medicine and agriculture, polymer science, photochemistry, computers in chemistry, catalysis, and chemical education.

**August 27 - September 1**

**5th International Environmental Education Conference**
Location: Cusco, Peru
Contact: MSc Eduardo Gil Mora, National University of Cusco, Zaguán del Cielo L-9, Cusco, Peru
The conference will focus on the relationship between the environment and development, and on the changes needed in today's behaviour for tomorrow's world. The program will enable participants to learn of developments, approaches and strategies in environmental education in different countries, and will cater for primary, secondary and tertiary educators; and for teacher trainers, curriculum developers, and policymakers.

**November 6-10**

**NABT Annual Convention**
Location: Souther Hotel, Nashville, Tennessee, USA
Contact: Patricia J McWethy, Executive Director, National Association of Biology Teachers, 11250 Roger Bacon Drive, #19, Reston, Virginia 22090, USA
The next annual convention of the National Association of Biology Teachers will focus on the theme Form and Function: How Should They Be Taught. Applications for program space are due on 15 March 1991.

**1992**

**January 3-6**

**ASE Annual Meeting**
Location: University of Sheffield, Sheffield, UK
Contact: Annual Meeting Secretary, ASE Headquarters, College Lane, Hatfield AL10 9AA, UK
Full details of this large international event will be circulated in *Education in Science*, a journal of the Association for Science Education.

**March 26-29**

**NSTA National Convention**
Location: Boston, MA, USA
International delegates are invited to participate in the International Round Table - one of the many features of this large convention. Each country is provided one or more tables in a large room where delegates can display and present information on science education in their country. Visitors move from table to table, talking with the various representatives. If you require an invitation to participate, write to John E Penick, Professor and Coordinator, Science Education Center, The University of Iowa, Iowa City, Iowa 52242, USA.

**March 29 - April 10**

**Science Teacher Education**
Location: London, UK
Contact: Courses Department, The British Council, 10 Spring Gardens, London SW1A 2BN, UK
This British Council International Seminar will be directed by John Head and John May of King's College Centre for Educational Studies, University of London, and will focus on secondary level teacher education, although some aspects will be of interest to those involved in primary science teaching. There are vacancies for 30 international participants - practising teacher trainers, advisers, inspectors, organisers of professional development programs and policy maker.

**April 22-29**

**Symposium on Technology Education**
Location: University College of Education, Erfurt, Germany
Contact: Prof D Blandow, University College of Education, Nordhäuserstraße 63, 5064 Erfurt, Germany
This symposium will be the first pan-European meeting on technology education to be held in a unified Germany - at an institution in Erfurt renowned for initiatives and developments in technology education. The principal aim of the symposium, which is being organised in collaboration with a number of organisations including ICASE and INSITE, will be to discuss technological literacy and competence in technology education within a European dimension. The majority of participants will be from European countries, with a few key people from other regions of the world. The principal language of the symposium will be English.

**May 11-15**

**Second International History Philosophy and Science Teaching Conference**
Location: Queen's University, Kingston, Ontario, Canada
Contact: Prof Skip Hills, Faculty of Education, Queen's University, Kingston, Ontario, Canada K7L 3N6
This conference follows the very successful First International Conference on History, Philosophy and Science Teaching held at Florida State University in November 1989. All conference papers will be published in advance of the conference. Accounts of the application of history and philosophy of science in the science classroom are welcome, as are research papers on the issue.
Extending and improving education in science for all children and youth by assisting member associations throughout the world

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International Space Year 1992
Association for Science Education
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Hatfield, Herts AL10 9AA
UK

Mr Brenton Honeyman
Editor, ICASE Journal
10 Hawken Street
Monash ACT 2904
Australia

ICASE - supporting science teachers around the world
ICASE News

Feature Articles

Individual or group work: where will pupils learn better science? M Mamalinga
Towards better science teaching in Bangladesh A M Sharafuddin & A K M Shamsudduha
Using the JETS program to catch the girls young for science and technology in Nigeria P A Okebukola

Science Education Around the World 18

Research for Teaching and Learning 22

Enhancing elementary students’ attitudes towards science W C Kyle Jr, R J Bonnsetetter, M A Sedotti, D Dvarskas

Science Teacher Education 27

Native American elders teach science P Nelson & C Bradley

Primary Science 29

Science Technology Society 31

Science & technology in action in Ghana P Towe & J Anamah-Mensah

Resources 35

Calendar 36

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Individuals £9 per annum, Libraries £18 per annum

or to one of these subscription centres:

John Penick, ICASE Special Projects
Science Education Center, University of Iowa, Iowa City IA 52242, USA
Individuals US$15 per annum, Libraries US$30 per annum

Brenton Honeyman, Editor, The ICASE Journal
10 Hawken Street, Monash ACT 2904, Australia
Individuals A$20 per annum, Libraries A$40 per annum

Dates for Receipt of Contributions

<table>
<thead>
<tr>
<th>Issue</th>
<th>Closing Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>March</td>
<td>1 February</td>
</tr>
<tr>
<td>June</td>
<td>1 May</td>
</tr>
<tr>
<td>September</td>
<td>1 August</td>
</tr>
<tr>
<td>December</td>
<td>1 November</td>
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This section provides news for the information of member associations, institutions, centres, foundations and companies. The Executive Committee encourages members to reproduce this section in journals and newsletters to communicate this information to as many as possible.

5. Strengthen international exchanges

Appropriate curricula

One area which should be considered in developing a more appropriate science curriculum is biotechnology. This was proposed by the first plenary speaker. New areas of research, such as biotechnology, have had a profound impact on the world at large and thus needs to be seriously considered as part of the school science curriculum. Areas of appropriate biotechnology (and selecting biotechnology that is appropriate to the country is important) may include (1) the production of energy using biomass; (2) the production of medicines using herbs; (3) food preservation; (4) food production; and (5) agricultural industries such as tea and rubber.

Innovations in teaching

One innovation in science education suggested by the speaker from Thailand was the inclusion of project work. This has a role to play in making science education more relevant by allowing for more student involvement in the thinking, design and planning stages, and it allows the teacher to adopt the role of 'guider' rather than

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Eighth ICASE Asian Symposium

Colombo, Sri Lanka

2-10 August 1992

THEME

Science Education for a changing world

The Symposium aims to identify some of the changes affecting our daily lives and to discuss ways by which science education can respond to these changes.

Subthemes include (1) technology, (2) appropriate technology (3) environment, and (4) scientific literacy.

Contact: Mr Asoka Weerasinghe, Hon. Joint Secretary

SLASME, Institute of Computer Technology

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Organised jointly by ICASE and the SLASME
Stepping into Science
Award Scheme
An ICASE Primary Science Project

The Stepping into Science Award Scheme has been organised to encourage children to take steps in science each year during their elementary/primary years. The steps are colour coded as follows:

Yellow for preschoolers
Green for grade 1 children
Blue for grade 2 children
Red for grade 3 children
Orange for grade 4 children
Grey for grade 5 children
Purple for grade 6 children

For further information about the scheme and how to order certificates contact the Project Officer: Sue Dale Tunncliffe
18 Octavia, Bracknell, Berkshire, RG12 4Yl, UK

'giver'. Four types of project work in science education were suggested:
1. Exploration and survey
2. Experimentation
3. Inventions
4. Theory formation

Technology in education
The presentation on technology in education proposed that technology education is a vital component of teaching if science education is to be relevant. However, teachers have generally experienced difficulty in teaching technology education because teachers do not understand the meaning of technology education, and teachers fail to cover the full range of learning skills when teaching their students.

Teaching strategies play a very critical role in science education (irrespective of the syllabus content) and more emphasis is needed on the process of learning rather than only considering the final knowledge outcomes.

Technology products such as locally produced apparatus can aid the teaching and learning process but, in most situations, the computer has yet to become an effective technological product for science teaching because of the lack of good software.

Research in science education
The plenary speaker considering research in science education suggested that, if student achievement is to be increased, the following outcomes of research need to be addressed:
1. The need for professional training of teachers is important.
2. Teachers' subject knowledge is important (not only knowledge of the topic in the textbook, but also knowledge of the associated technology in society).
3. Examination-centred teaching strategies are not the most appropriate for effective learning.
4. The type/mode of teaching instruction and the teacher's enthusiasm affect student achievement.

Conclusion
This symposium was a first for ICASE, involving instantaneous translation between Chinese and English. It is planned to produce the proceedings in English in the near future. For further details, write to:

Prof Mi Zihong
Department of Physics
East China Normal University
Shanghai 200062, China

Coming ICASE Events
For further details about these ICASE endorsed events, consult the Calendar in this issue.

April 22-29, 1992
Symposium on Technology Education, University College of Education, Erfurt, Germany
Contact: Prof D Blandow, University College of Education, Nordhäuserstraße 63, 5064 Erfurt, Germany

June 10-12, 1992
ICASE Research Seminar on Chemistry and Physics Education, University of Dortmund, Germany
Contact: Prof Dr Hans-Jürgen Schmidt, University of Dortmund, Department of Chemistry, Otto-Hahn-Straße, 4600 Dormund 50, Germany

August 2-10, 1992
Eighth ICASE Asian Symposium, Colombo, Sri Lanka
Contact: Mt Asoka Weerasinghe, Hon, Joint Secretary, SLASME, Institute of Computer Technology, PO Box 1490, Colombo, Sri Lanka
Individual or Group Work
Where will pupils learn better science?

by Maria Mamalinga
Department of Education
University of the Aegean
Greece

The suggestion that groupwork causes pupils to focus on superficial, less abstract aspects of learning tasks and to be dominated by a need to agree within the group at the expense of a need to be logical was investigated. A sample of forty four 15 year old Greek pupils were given the same test items in two different social contexts. In the first context, pupils were tested in a conventional classroom manner, each filling in their own answers with no inter-pupil cooperation. In the second context, pupils were divided into groups of four and asked to fill in just one set of test questions communally. They were encouraged to talk amongst themselves during the work and the conversations were recorded. The explanations produced in the individual tests and the conversation and explanations from the group contexts were both analysed for the nature and quality of ideas used. The working hypothesis that the group context would produce more superficial ideas was not supported. The ideas raised and used were more or less the same in each case. Also, and again contrary to expectations, the group context produced fewer incorrect ideas than the individual situation. The reasons for these findings and the implications for science teaching are discussed.

Introduction

Science pupils working together in small groups is common in schools and, over the years, there have been studies which have investigated or argued the good or bad effect of group and individualised teaching methods on science learning. Johnson and Johnson (1979) for example suggested that cooperative learning might produce better academic performance than individualised instruction.

However, in her wide ranging review Solomon (1987) makes a number of specific suggestions which follow from the ideas of sociology of knowledge being applied to science lessons. Among other things she argues that:

"Both sociological theory and classroom evidence suggest that in socially acquired knowledge, exchange of meaning and consensus take the place of logical testing and typification by context replaces abstraction and conceptualisation."

(Solomon, 1987)

After translation, the suggestion here seems to be that, when pupils are working in groups, they may find the need to agree amongst themselves stronger than the need to be logical. Similarly, they could find that superficial and obvious features of the problem context are easier to agree on than abstract constructions. Pupils working alone (in apparently less constrained social contexts) may not have their thinking restricted in the same way. These ideas seem to contradict the argument that group learning encourages better problem-solving learning. It is important to look carefully at these conflicting possibilities. Recent experimental studies of these issues have been somewhat ambiguous. Sherman (1988) and Lazarowitz et al (1988), in different educational contexts, both obtained results which did not indicate any clear benefit of group over individualised instruction. The likely advantages and disadvantages of pupils working together or individually is not sufficiently well understood.

The social context of learning must influence the nature of what is learned (see the review by Solomon (1987) for many interesting references). Social context here means more than the obvious notion of pupil discipline and classroom manners. The social complexities of what, why and how pupils learn science, when they are put into the socially artificial situations of even the best run classroom, need to be probed in order to throw some light on the questions raised.

The concern of science teachers is to develop meaningful learning in the classroom by interacting with the pupils, though the interaction between teacher and learner is not the only one which is taking place. Interactions between pupils are a strong factor which must also affect learning and the presumption that these effects are beneficial has prompted the arguments for group learning. In a recent paper Kutnick (1990) argues persuasively that the social act of cooperation in learning science may be a key factor which has not been considered in the attempts to apply psychological principles such as those of Piaget to science curriculum development. Kutnick pleads for small group learning situations so that pupils can "come to their resolutions without the domination of specific control of teachers or authoritarian peers."

(Kutnick, 1990)

More general theories of the role of the social context on the development of knowledge have had a chequered history (Mulkay, 1979) especially when applied to science knowledge. Until recently science knowledge, unlike other kinds, was accepted to be objective and independent of the social context (Stark, 1958). This suited scientists very well since it gave their work a special status. Recently this view of science knowledge has been challenged (Knorr-Cetina,
1981) and the nature of the social pressures on science knowledge development are now being studied. The focus of the social context in question is usually the relationships between scientists working together, between competing research groups, between peer scientists and between scientists and society at large. Unfortunately, none of this directly relates to the sociology of the classroom, where a very different set of social pressures create the setting in which pupils' science knowledge is expected to develop. Since science classrooms are the places where budding scientists may be set on the road to professionalism, the study of the social influences on the context of science learning is overdue. Teachers and curriculum developers really do need to know when group or individualised work is appropriate for what has to be learned.

Aims of the Study

The aim of this study is to investigate how the social context might affect 'thinking' about school chemistry in class. Specifically it was decided to investigate whether the kinds of ideas used in a group problem solving situation, in which groups of pupils were made to cooperate and therefore negotiate with each other, differ from the ideas used in solving the same problems in an individualised test situation. If Solomon's (1987) suggestions are correct then pupils working without interfering social pressures should produce results which are more logical and more focused on the abstract nature of the task. If, on the other hand, the suggestions of Kutnick (1990) and Johnson and Johnson (1979) are correct then the group context should produce better results.

Research Method

As part of a larger test of science learning, the Assessment of Performance Unit (Driver et al, 1984) used written questions to investigate the conceptualisations held by 15 year old pupils in the UK of ideas about elements, mixtures, compounds and chemical change. The written questions were designed for and used in individualised test situations with no student-student interaction. Four of the problems investigated the following questions: (1) What ideas do students have about 'element', 'mixture' and 'compound'? (2) How do students interpret commonly used diagrams representing elements, compounds and mixtures? (3) What observations do students consider as evidence for chemical change? (4) How do students perceive the role of the relative masses of the reactants in a chemical reaction? The problems required decisions about a problem situation and also required extended written explanations. An example of one problem is presented in Figure 1.

For these established problems to be used in the present experiment a group testing technique was required based on the same main test. It was not clear at the outset just what evidence we should be looking for concerning the hypothesis. Consensus requires agreement within a social group. Solomon's (1987) suggestion implies that this will be easier to achieve when 'attractive' superficial ideas (correct or incorrect) are the focus of attention in the group. In other words, the pressure on the individuals of the group is to focus on what they can all agree on rather than on what the logic of the task may actually require, especially if the problem has abstract requirements as in these chemistry tasks. Thus the hypothesis became that if group problem solving is 'consensus' (rather than 'task-logic') driven, then the ideas raised in the group tests would be less rich, less abstract and more related to the superficial features of the task as given. It was necessary to look for 'features' which the groups attended to and to compare these with what the individuals attended to.

The four problems used required explanations by the pupils of their answers and these, rather than the correct/incorrect nature of the answers, were analysed for their contained ideas in order to build a rough picture of the 'individual's ideas'. Groups of students were asked to solve the problems communally and the ensuing discussions were recorded. Analysis of these discussions allowed the 'group's ideas' to be characterised in a similar way.

Two is the minimum number for a group. Barnes and Todd (1977) suggested that to have more than four children in a group is not advisable as there is a risk that one or more members will remain silent. Also, when the time available for group discussion is limited, each extra person in the group means less time available for individuals to talk. Furthermore, to have more than four children in a group may restrain the social organisation of the group and possibly divert the students (who are used to being controlled by the teacher) from their main task. For these reasons it was decided to use groups of four pupils. One test booklet containing exactly the same five-item test as used on an individual basis was given to each group. The members of

A pupil was studying the properties of an unknown chemical X.

Here are the results of some of his tests:

- At room temperature X is a white solid.
- It has a melting point above 200°C
- It dissolves in water to give a colourless solution.
- When it is melted it gives more than one product on electrolysis.
- When it is heated in air it forms a white oxide.

As a result of these tests, the pupil claimed that X was not an element.

Do the results support this claim or not?

Explain your reasons:


Figure 1
the group were instructed to discuss the problems in order to
write down test answers with which they all agreed. In this
way they were forced to cooperate and discuss openly what
they separately thought.

There was a problem of how to choose the members of each
group. On the one hand, if the criterion is friendship, this
may make the discussion more comfortable. We share our
ideas more openly with people we trust. On the other hand,
in arbitrarily chosen groups, there is more challenge to
express ideas explicitly and to explain them more clearly.
Overall, it was decided that self-selected groups, probably
containing friendship groups, would minimise the working
problems since there was only a very limited time for pupils
to solve the problems. Time would be wasted while the
pupils got to know each other in non-friendship groups. No
attempt was made to control the sex or ability composition
of the groups. The group discussions were tape recorded.

The experiment was carried out on the Greek island of
Rhodos. A sample of pupils was chosen from all the first
year (age 15) general lyceum classes of Rhodos and from the
first year class of the technical/vocational lyceum. All eight
lyceum of the island cooperated and eleven intact classes of
pupils completed the individualised written test. The urban
lyceum were much bigger schools than the village lyceas.
Therefore, two classes of pupils from each urban and one
class of pupils from each village general lyceum were tested.
All the classes were taught by different teachers. The way the
classes were chosen from within the schools was random.
Though this was not a strictly random sample, the pupils
tested should be a representative sample of the children in the
age range on Rhodos island. The sample for the present
investigation was a subset of this overall sample.

The four questions used were Greek translations of the items
used in the Assessment of Performance Unit test described
above. All of the data and the analyses were in the Greek
language.

After careful thought it was decided to test the sample of
pupils first as individuals and then divided up into groups of
four without the pupils being told the results of their
individual tests. Since the pupils will be the same in both
test contexts, and no new learning will have taken place
between tests, any differences in the nature of the ideas must
be due to the nature of the test context in each case. The
reverse order of tests, even as a control group, could not be
used because the pupils will learn from each other in the

### Table 3

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>FREQUENCY</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td>35</td>
<td>47.29</td>
</tr>
<tr>
<td>Comprehension</td>
<td>18</td>
<td>24.32</td>
</tr>
<tr>
<td>Application</td>
<td>11</td>
<td>14.86</td>
</tr>
<tr>
<td>Synthesis</td>
<td>10</td>
<td>13.51</td>
</tr>
<tr>
<td>Affective</td>
<td>0</td>
<td>0.00</td>
</tr>
<tr>
<td>Total</td>
<td>74</td>
<td>100.00</td>
</tr>
</tbody>
</table>

Thus it was decided to have all the pupils in the sample do
the individual test first. Volunteer groups of four pupils, one
group from each class (eleven groups, 44 pupils), were then
taken to separate rooms, given one group-test booklet each
and left to get on with producing agreed group answers. This
organisation was chosen to ensure that the pupils could start
talking about the problems straight away, having just
answered them individually. The discussions took place with
no interference from the experimenter or from the class
teachers. The test-booklets produced by each group (eleven
booklets), the recordings of the group discussions (eleven
transcripts) and the individually answered tests (44 booklets)
by the same 44 pupils provided the raw data for the
experiment. The testing was started and completed within

Unlike previous studies, the purpose of the investigation was
not to see whether the group answers were simply more or
less correct than the individual tests using conventional
academic criteria. The purpose was to probe the nature, the
range and quality, of the ideas employed in the two test
situations. The explanations given to each question by the
pupils when working individually were first examined
carefully to identify and list the whole range of ideas
expressed. Statements which could be interpreted to imply
substantive concepts related to the test topic were extracted
from the pupils' written explanations and listed. The group
written explanations and the group discussion transcriptions

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**Around the World**

**1991 Edition**

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The Editor, Who's Who in Science Education, 10 Hawken St, Monash ACT 2904, Australia
were then treated in the same way. Concept inventories were formed of the ideas which pupils used to produce answers. As the test contained four questions, eight overall concept inventories were produced, four from the combined group discussions of each question and four from the total individual responses. Also, two concept inventories were produced for each separate group of four pupils for each question, one from their group discussion data and one from their individual tests. This produced 88 smaller concept inventories.

Three analyses were carried out. Firstly, the substantive statements in the group and in the individual data sets were analysed question by question for the range and nature of ideas present. Secondly, the substantive statements in the total individual and total group test data were categorised, where possible, as representing abstract or superficial ideas (in many cases a judgement could not be made). Thirdly, the joint explanations and discussions by each sub-group of four pupils were separately categorised using a rough judgement of the pupils' performances, group by group and question by question.

Results and Discussion

1. The nature and range of ideas in the two contexts

In problem 1 the pupils were presented with descriptions of five substances and had to use their knowledge of what an element is to decide which, if any, of the substances could be elements. The five alternatives contained a number of physical and chemical properties (eg colour, physical state, reacts to give, etc) which provide attractive, salient though incomplete criteria for decision making. Analysis showed that the range of ideas expressed in the group responses was more or less the same as the range of ideas expressed in the individual responses. Also, the nature of the responses was broadly similar, mostly reflecting the words and ideas raised in the test items, as was to be expected. The pupils mostly thought of elements as 'being made up of one component only', using this idea to solve the problems. There was not much evidence of the abstract particulate model in either context.

Problem 2 was similar to problem 1. The pupils were given descriptions of a 'substance X' (eg at room temperature it is a white solid) and were asked to decide which if any of the evidence supported the view that the substance was an element. The key information in the item was that the chemical 'gives more than one product on electrolysis'. This became the focus of attention in both contexts. Overall the only evident difference was that there were considerably more references to the same ideas in the individual tests than in the group recordings. This is because one statement of an agreed idea suffices in the group context whereas all four students may write the same idea as individuals.

Question 3 required the pupils to think about their idea of a chemical reaction. A before-and-after situation was presented and the pupils had to decide whether a reaction had taken place using criteria such as colour change and change of density of a substance that had been heated. Not enough evidence was given for the pupils to make a certain answer. Changes in mass, colour and density are all indicative of a reaction but not conclusive on the basis of the data given. In both individual and group contexts there was a focus on these changes but very little evidence in either context of discussions about whether a new substance had been formed. Only two pupils, in separate groups, raised the idea of molecular rearrangements. They also raised them in their written explanations. Once again the overall data are more or less the same in the two contexts.

Question 4 investigated the pupils' ideas of stoichiometry in reactions. They were presented with a description of a quantitative process and asked to think about the consequences of doubling one of the reactants on the quantity of product. If the pupils knew a descriptive law of constant composition then they could answer this question. The discussion in the group and the comments in the individual tests both focused on getting a clear idea of the law to use in this problem. The ideas raised seem to be similar in both contexts.

Taken all together these analyses show that there is not a lot of difference in the range and quality of ideas raised and used by the pupils in the individual and in the group contexts. There is nothing in this evidence to suggest that the social context of the group situation restricts the students ability or tendency to attend to the ideas which usefully contribute to the problem at hand as Solomon (1987) anticipated.

2. The abstract/concrete nature of the ideas used

In the context of these problems, 'abstract' was judged to be the spontaneous and clear use of the particulate model (ie thinking about atoms and molecules). 'Concrete' was used to categorise responses which were obviously either related to real objects and events or to words in the statement of the given question. For pupils at this level the particulate model is known to be difficult and this probably relates to its abstract nature. The items all required the pupils to think about their ideas of reactions, elements and compounds and this could be done with or without the particulate model. The twenty most frequently used ideas in all the individual and the group data put separately together are listed in Table 1:

<table>
<thead>
<tr>
<th>Rank</th>
<th>Individual</th>
<th>Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>element</td>
<td>element</td>
</tr>
<tr>
<td>2</td>
<td>gives/reacts</td>
<td>gives/reacts</td>
</tr>
<tr>
<td>3</td>
<td>increase</td>
<td>change</td>
</tr>
<tr>
<td>4</td>
<td>mass</td>
<td>mass</td>
</tr>
<tr>
<td>5</td>
<td>remain</td>
<td>compound</td>
</tr>
<tr>
<td>6</td>
<td>substance</td>
<td>product</td>
</tr>
<tr>
<td>7</td>
<td>expand</td>
<td>expand</td>
</tr>
<tr>
<td>8</td>
<td>ratio</td>
<td>ratio</td>
</tr>
<tr>
<td>9</td>
<td>compound</td>
<td>remain</td>
</tr>
<tr>
<td>10</td>
<td>product</td>
<td>substance</td>
</tr>
</tbody>
</table>

% use is the occurrence frequency of the idea divided by the number of pupils (44) multiplied by 100
The most striking feature of these data, apart from the similarity of the two lists, is the lack of abstract ideas other than the notion of ratio, which is normally thought of as abstract. The rest of the list of ideas can be adequately thought of as representing concrete and real phenomena. In fact, the ideas of atoms and molecules hardly show up at all in the ideas considered by the pupils in either context. On the basis of these data, it is not possible to conclude that the group context inhibits abstract thought relative to the individual context.

3. The quality of the answers individually and in groups

This analysis showed a clear and important difference between the two contexts. The analyses presented above did not look at whether pupils used ideas correctly; 'molecules are made up of atoms' would produce the same data as 'atoms are made up of molecules'. In this analysis, the pupil comments, written or spoken, were analysed for their correctness. The aggregated ideas used by pupils working as individuals were compared with the ideas produced when discussed together in groups of four. The ideas in both cases were categorised using a scheme similar to that developed by Briggs and Holding (1986). The categories were (1) acceptable ideas about the topic under investigation, with reasoning given; (2) acceptable ideas used inappropriately with no, or wrong, reasoning; and (3) formally unacceptable ideas. The results are shown in Table 2.

<table>
<thead>
<tr>
<th></th>
<th>Q1</th>
<th>Q2</th>
<th>Q4</th>
<th>Q5</th>
<th>Overall Results</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>accepted ideas</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>used correctly</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>individuals</td>
<td>25</td>
<td>45</td>
<td>67</td>
<td>78</td>
<td>55</td>
</tr>
<tr>
<td>group</td>
<td>78</td>
<td>67</td>
<td>65</td>
<td>100</td>
<td>74</td>
</tr>
<tr>
<td><strong>accepted ideas</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>used incorrectly</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>individuals</td>
<td>7</td>
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<td>19</td>
<td>6</td>
<td>1</td>
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<tr>
<td>group</td>
<td>7</td>
<td>16</td>
<td>30</td>
<td>0</td>
<td>16</td>
</tr>
<tr>
<td><strong>wrong ideas</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>individuals</td>
<td>68</td>
<td>45</td>
<td>14</td>
<td>16</td>
<td>34</td>
</tr>
<tr>
<td>group</td>
<td>15</td>
<td>17</td>
<td>5</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td><strong>totals</strong></td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 2
The quality of the ideas used in individual and group contexts
(% of total for each question in each context)
majority of the group. It is necessary to be cautious making
suggestions such as this since the data here is very limited
and was obtained in a test situation rather than a teaching
situation, though the two may not be so different. In both,
most of the pupils are endeavouring to build on their
knowledge by using new, difficult and probably ill
understood ideas. The confidence from sharing difficulties
may have a beneficial effect, apart from reducing the exposure
of incorrect ideas.

Conclusions and Implications

Generally, the group answers contained better reasoning than
the individual ones with fewer mistakes and better ideas.
There was no evidence that the range of ideas was reduced in the
group context or that the ideas were more superficial.
Abstract ideas were few and far between in either context.

It may be possible to conclude that the group situation was a
better learning situation since wrong ideas seemed to be
suppressed. Maybe, in the individualised context, some
pupils knew that their written statements were wrong or else
did not know an answer at all, but were obliged to write
something. It may be that the individualised situation, which
must appear more threatening to the pupils because of this
need to get an answer which the teacher will judge, is a poor
learning situation because it allows, even necessitates, pupils
to think and use wrong ideas. Perhaps freedom from this
pressure allows the exchange of opinions which takes place
in a group, with the variety of spoken ideas, to offer to
pupils a more integrated and productive perception of
problems.

No evidence for a greater dominance of consensus over logic
or concrete over abstract ideas in group discussion was
diagnosed in the experiment. On the contrary, the group
performances contained more formally correct ideas than the
individual explanations. This probably means that the
reasoning was more logical in the groups which, again,
probably makes it a better learning context for the majority
of pupils in these difficult problem solving topics. This
suggestion rationalises the results of Lazarowitz et al (1988)
who found a positive advantage with group learning
compared with individual instruction in a topic requiring high
level thinking but found a negative advantage when the topic
was more to do with information gathering.

An unquestionable feature of small group learning activity is
that it necessarily presents learners with other opinions other
than their own. Furthermore the learners have to make their
own ideas explicit to others who may not agree with them.
This necessitates a self-conscious consideration of personal
knowledge. It is likely that the use of small group discussion
as a part of a larger teaching strategy would be advantageous
for these and maybe other reasons.

Though Solomon’s (1987) prediction that group learning will
constrain the ideas that pupils use in learning seems, in this
particular case at least, not to be evident, her main point that
social influences are a central factor is undoubtedly true. It is
very important that science educators start to look seriously
at the relation between learning and the social context in
classrooms so that correct advice can be given to teachers,
curriculum developers and testers.

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Towards Better Science Teaching in Bangladesh

A Report on the Secondary Science Education Project

by Dr A M Sharafuddin & Dr A K M Shamsudduha
Secondary Science Education Project
Ministry of Education, Bangladesh

Background

In today's world, science has a decisive role in meeting the requirements of mankind and in bringing about economic development and social transformation. Hence in the education systems of both the developed and developing countries, science is being given an increasingly greater role. "Science For All" has become an accepted maxim, and a minimum scientific literacy of the entire population is considered an essential pre-requisite for development.

In Bangladesh, during the 1980s the improvement of science teaching at the secondary stage has been particularly emphasised because it is terminal for a large number of pupils and also because it forms the foundation of higher education for others. Consequently, efforts are being made to make science teaching more effective and meaningful.

In 1982-83, the Directorate of Secondary and Higher Education (DSHE) of the Ministry of Education (MOE) launched two schemes for science teaching - one for improving science facilities in 1200 non-government secondary schools, and the other for improving such facilities in 150 non-government madrasahs. The schemes included construction of science laboratories, provision of furniture, equipment, chemicals, books and teaching aids, and in-service training for science teachers.

Meanwhile, the Asian Development Bank (ADB) showed interest in providing financial assistance to Education Sector projects concerned with science and vocational education. Consequently, the implementation of the two schemes was suspended and, at the request of the Government, the ADB provided a technical assistance grant and engaged a four member team from Unesco to make a study which was completed in September 1983.

After a series of meetings between representatives of the GOB and the ADB Fact Finding Mission (November 1983), the Pre-Appraisal Mission (February-March 1984) and the Appraisal Mission (May 1984), it was decided that the two schemes would be combined. Accordingly, a Memorandum of Understanding between the GOB and ADB was signed in May 1984, followed by a Loan Agreement between the GOB and the ADB in November 1984.

The revised scheme entitled "Secondary Schools Development Project with Emphasis on Science Education" (commonly known as the Secondary Science Education Project) has been under implementation since April 1985, the date the loan became effective.

Objectives

The main objective of the project is to improve the quality of secondary education in Bangladesh with particular emphasis on science education. This is expected to lead to the establishment of science as a basic component of the school curriculum, increased supply of science-oriented manpower, and introduction of integrated science for all as a part of the core curriculum in grades 9 and 10. The specific objectives of the project are as follows:

1. To improve the quality of secondary science education and secondary education through upgrading education facilities and the professional competence of teachers, teacher trainers and administrators.

Photo: Pupils doing an experiment in a science class in a rural Project school
2. To make access to secondary science education more equitable and to reduce the gap in educational facilities between the urban and the rural areas.

3. To institutionalise inservice training and strengthen preservice training of secondary teachers, particularly science teachers.

4. To provide fellowships for staff development of Secondary Education and Science Development Centres (SESDCs), training colleges and supervisory personnel.

5. To promote and strengthen academic supervision of secondary schools, educational research, innovation and development of instructional materials.

6. To strengthen the capability of the Directorate of Secondary and Higher Education to plan, manage, monitor and evaluate secondary education through institution building and organisational reforms.

**Project Components**

The major components of the project are the following:

A. Project Implementation Unit (PIU)

The PIU, consisting of 12 officials and supporting staff, has been established on the fifth floor of DSHE at an estimated cost of Tk 2,316 million (US$1 is approximately equivalent to 35 Taka, the Bangladesh monetary unit).

B. Classrooms and laboratories

The Project provides for the construction of laboratories and multipurpose rooms, and for repairs and renovations in 1700 institutions which are most deficient in respect of science facilities. Construction work to be completed includes (1) one laboratory and one multipurpose room, measuring 111.60 sq m at an estimated cost of Tk 300,000, in 1200 high schools and 138 Dakhil Madrasahs (for teaching SSC-level science); (2) one multipurpose room (measuring 69.75 sq m at an estimated cost of Tk 187,000) in 300 high schools and 50 Dakhil Madrasahs ; (3) two laboratories and one multipurpose room (measuring 192.50 sq m at an estimated cost of Tk 516,000) in 12 Alim Madrasahs (for teaching HSC-level science; (4) repair and renovation of the 1700 institutions mentioned above at a cost of Tk 20,000 each.

C. Secondary Education and Science Development Centres

A National Secondary Education and Science Development Centre (N-SESDC) has been set up on the campus of the Teachers' Training College (TTC), Dhaka at an estimated cost of Tk 17.972 million. In addition, eight Secondary Education and Science Development Centres (SESDCs) have been set up on the campuses of eight other TTCs at a total estimated cost of Tk 87.648 million. The N-SESDC and SEDSCs will provide inservice training to teachers, supervision of classroom teaching in nearby Project schools, and function as resource centres for the improvement of classroom instruction. On completion of the Project, about 10,000 teachers will receive inservice training at the 9 centres each year.

D. Science Equipment and Teaching Aids

An estimated amount of Tk 172.804 million is being spent on the provision of essential science equipment, chemicals and teaching aids to 4000 institutions. This includes (1) Tk 55000 to each of the 1338 institutions with two rooms; (2) Tk 37000 to each of the 350 institutions with one room and 2300 institutions not having construction; and (3) Tk 97000 to each of the 12 madrasahs with three rooms.

E. Furniture

Each of the 1700 institutions with construction work, the 21 Zonal Project Offices, the 9 SEDSCs and the PIU are being provided with necessary furniture at a total estimated cost of Tk 54.635 million.

F. Books and Reference Materials

There is a provision of Tk 11.00 million for books and reference materials. Each of the 4000 institutions included in the project has been given books worth Tk 1300. The allocations for the N-SESDC and the SEDSCs are Tk 1.550 million and Tk 4.00 million respectively.

H. Fellowships

There is a provision for 368 man-months of overseas training for staff development for the PIU, N-SESDC, SEDSCs, Zonal Project Offices and selected teachers of project institutions.
I. Consultancy

There is a provision for 6 Consultants (for a total of 137 man-months) for assisting the PIU in project implementation, particularly in planning and organising the training programs. The UNDP made a Technical Assistance Grant of US$2.0275 million for financing the Consultancy and Fellowship components.

Management and Administration

The overall responsibility for implementation of the project lies with the Director General, Secondary and Higher Education, Bangladesh. The day-to-day management is left to a Project Implementation Unit (PIU) headed by a Project Director (PD). The PD is assisted by 2 Deputy Project Directors, 2 Assistant Project Directors, 2 Engineers, 1 Procurement Officer, 2 Research Officers, 1 Administrative Officer, 1 Accounts Officer and a supporting staff of 30.

At the field level, 21 Zonal Project Implementation Offices (ZPIOs) have been established at 21 old district headquarters for close monitoring and ensuring project implementation. The ZPIOs are attached to the existing District Education Offices and headed by a Zonal Project Officer (ZPO). The ZPO coordinates with other agencies responsible for implementation of the Project such as the Facilities Department and the managing committees of the institutions. The ZPO is also responsible for the academic supervision of the Project institutions.

Other Cooperating Agencies

In addition to the PIU, three agencies are taking a major share in the implementation of the Project. These are the Facilities Department, the Bangladesh Educational Equipment Board (BEEB) and the Teachers' Training Colleges (TTC). The Facilities Department, with its Zonal and District Offices throughout the country, has been entrusted with the construction of science classroom-laboratories in the Project schools, the office of the PIU and the SESCDs. BEEB has taken the procurement and distribution of science equipment to the schools. The TTCs have assisted with the organisation of short in-service courses on their campuses, particularly during vacation periods. In addition, the National Curriculum and Textbook Board (NCTB), Bangladesh Bureau of Educational Information and Statistics (BANBEIS) and the National Institute of Educational Administration, Extension and Research (NIEAER) have been cooperating in various aspects of implementation of the Project.

Project Coordination Committee

A Project Coordination Committee (PCC) consisting of representatives of (MOE), DSHE, the Facilities Department, BEEB, NIEAER, NCTB, N-SESDC, Dhaka and others as needed, has been set up to coordinate the Project. The Education Secretary, or his representative, chairs the PCC with the Project Director as Member-Secretary. There is also provision for the creation of Project Implementation Committees (PICs) at the divisional and institutional levels, as necessary.

Project Financing

In the revised Project Proforma, the estimated investment cost of the Project has been shown as Tk 1122.389 million. The major share of the cost is being borne out of the loan from the ADB (79.9%). The Consultancy Services and Overseas Fellowships are being provided out of the Technical Assistance grant of the UNDP (5.69%). The Government of Bangladesh is funding the remainder (14.39%) of the cost.

Project Implementation

The physical progress of implementation as of June 1990 is as follows:

- Out of 1700 schools and madrasahs, construction work has been completed in 1679 and the remaining ones are at various stages of completion.
- Construction of all the 9 SESDC buildings has been completed.
- The PIU building on top of the Shikkha Bhaban has been completed.
- Furniture has been provided to all institutions where construction has occurred. Office furniture for the PIU and the N-SESDC has also been procured.
- Imported science equipment and chemicals have been delivered to all Project institutions to the extent of about 80% of allocation.
• Funds have been placed at the disposal of all Project institutions (Tk 1300 per institution) for the purchase of books as supplementary reading materials.

**Inservice Training**

A total of 11,172 secondary school teachers and administrators have been provided inservice training - mostly of 2-week and 3-week duration. The subject-wise breakdown of the trainees is: 2848 in biological science, 2587 in physical science, 1523 in mathematics, 3086 in social science, 757 in Bengali and 371 in educational administration, including orientation courses (4-7 days) highlighting educational management for 171 teacher trainers and ZPOs.

**Overseas Fellowships**

Out of a provision of 368 man-months of overseas fellowships, 75 fellowships totalling 115.5 man-months have been utilised. Three short term courses in Academic Supervision, of 2-week duration each, were organised for the ZPOs and other staff of the Project (including 20 school science teachers) at The University of the Philippines. Two courses, of 4-month and 9-month duration respectively, for Project staff were organised at the University of Queensland in Brisbane, Australia. In July 1988, two officials of the Project attended the ICASE World Conference and the Unesco Seminar on Worldwide Developments in Integrated Science Education 1978-88, held in Canberra, Australia and also visited a number of institutions in Brisbane, Manila and Hong Kong on a Project Fellowship.

**Consultancy**

The full complement of 6 Consultants has been fielded. Their names and dates of joining are as follows: Dr A M Sharafuddin (February 1987), Team Leader and Science Education Development and Teacher Training Expert; Mr John E Reeves (March 1987), Physical Science Education Expert; Dr John W Ellick (March 1987), Biological Science Education Expert; Dr Orlando B Claveria (April 1987), Educational Management and Finance Expert; Dr Lourdes S Sumagaysay (September 1987), Mathematics Education Expert; and Dr Jasmin E Acuna (August 1988), Examination, Monitoring and Evaluation Expert.

The Consultants have made extensive visits to the Project schools, along with Project staff, to determine the needs of teachers and pupils, monitor the construction program and use of science laboratories and equipment, observe teaching methods and help teachers. They have also provided technical assistance in various Project implementation activities including the planning and preparation of training materials, conducting inservice courses, undertaking surveys on needs for training of teachers and problems of management of DSHE field offices and schools and on funding sources to support these schools.

The Consultants have worked in close cooperation with the N-SESDC staff and the PIU in preparing and testing self-teaching and inter-teaching modules (units) based on the new science textbooks and Teachers' Guides. Similarly, an instructional system for mathematics teacher training consisting of modules and lectures was developed. Procedures for monitoring and evaluating outcomes of in-service courses have also been designed and incorporated in the courses. Recommendations have also been made on enhancing the effectiveness of administration and management of secondary education and on reforming the examination system in Bangladesh.

**Project Benefit**

A pilot study was conducted during July-September 1990 to determine the impact of the Project after five years of operation. Questionnaires were administered through the ZPOs in 204 Project schools distributed all over the country and in 99 'comparable' non-Project schools as a control group. Data were gathered for 1985 and 1990 in respect of the schools' physical facilities and enrolment, and the assessment of headmasters and trained teachers on the impact of the Project inputs.

It was found that among the Project schools, 67% were co-educational, 25% only for girls and 8% only for boys. Among the non-Project schools, the proportions were 74%, 19% and 6% respectively. Of the Project and non-Project schools, 64% and 62% respectively, had electricity. These facts indicate that the Project and non-Project schools were, in fact, comparable.
The average number of teachers is 12.1 in Project schools and 13.3 in non-Project schools. On an average, 3 teachers of each Project school have so far been trained by the Project.

The Project schools in the villages show a 39% increase in enrolment over the 5-year period; those in towns show 37% increase. The comparable figures for non-Project schools are 37% and 21% respectively. In the cities, however, the Project schools show an increase of 27% but the non-Project schools 38%. In respect of science enrolment, the Project and non-Project schools show a similar increase in villages and towns; but in the cities, the Project schools show a much greater increase than non-Project schools - 41% versus 17%.

In terms of number of candidates appearing in the science group of the SSC examination, there is a marked increase between 1985 and 1989 among the Project schools; such increase is less marked for the non-Project schools. The Project schools, in general, report greater use of science equipment in their teaching compared to non-Project schools. This, obviously, is a reflection of the substantial input of equipment and teacher training to the schools by the Project.

In response to a separate questionnaire, the headmasters of Project schools view the major impact as improved physical facilities for science teaching, increased student interest and improved SSC performance, improved teaching skills of teachers and improved teaching climate. The trained teachers consider the most useful aspect of the training received by them to be the planning and organizing of practical work and teaching methods. Next in importance, in their view, are the laboratory skills and new science concepts.

Other Impact

With a view to keeping the teachers of Project schools abreast of the recent developments in educational thought, the N-SESDC has been putting out a Quarterly Project Bulletin named *Shikhaka O Biggan* since April 1988. Eight issues of the Bulletin have been published up to June 1990.

Largely as an outgrowth of the Project, a Bangladesh Association for Science Education (BASE) was formed in February 1988 by the professional staff of the Project and other concerned persons. The Association has since organised a number of seminars and sponsored annual national awards for two Best Science Teachers of Secondary Schools. A National Workshop on "New Directions in Secondary Science Education" was organised by the Association in cooperation with the Secondary Science Education Project during 9-17 May 1990. The Workshop was also sponsored by Unesco and UNDP. BASE has already been affiliated with the International Council of Associations for Science Education (ICASE). Some members of BASE have attended various international and regional meetings sponsored by ICASE.

Another indirect impact of the Project is the support it has been providing, along with BASE, to the promotion of various science club activities in the Project schools and other schools throughout the country. The Project organised a National Workshop on "Improvement of Science and Technology Education through Museums, Science Clubs and Science Fairs in Bangladesh" during 21-28 November 1989, in cooperation with the National Museum of Science and Technology, under the sponsorship of Unesco.

The impact of the Project is likely to gather momentum as all the Project inputs are completed, the N-SESDC network is fully operational and the provision of inservice training for teachers becomes a regular and systematic feature.

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Using the JETS Program to 'catch the girls young' for Science and Technology in Nigeria

by Peter A Okebukola & Rosy N Agholor

The Junior Engineers, Technicians and Scientists (JETS) program was introduced into the school system in Nigeria in 1987, primarily to foster the development of science and technology culture among youth. This paper reviews the contributions of the program to the improvement of the interest level of girls in Nigeria in science and technology, and the bolstering of the achievement levels of girls in science and mathematics. Four factors were identified as being components of the JETS program that have demonstrated great potential for the attainment of this objective. These are the institutionalisation of the Best Female JETS of the Year Award, the nature of JETS projects, the all-year-round national radio and TV airing of the National JETS Project and Quiz Competition, and the institutional-level JETS activities that are slanted towards female participation. Strategies mapped out for sustaining the interest of girls in JETS are also discussed.

The development to full potential of over 100 million citizens has been the core goal of education in Nigeria. This philosophical basis of the 1981 National Policy on Education has led the way to greater access of women to formal education. The Better Life for Rural Women and Adult Literacy Programs, among others, have combined to melt part of the pervasive cultural (especially religious) barriers to the education of women. A conservative estimate from data obtained from the Federal Office of Statistics indicates that a 3% annual growth rate in the enrolment of girls in schools has been recorded in the past five years. Unfortunately, a corresponding increase in enrolment in science, engineering and technology has hardly been observed. Reviews by Okeke (1989) and Bozimo (1989) show imperceptible spurts of growth in female enrolment in a few science-related disciplines. The goal of winning more women for science and technology, therefore, needs to be more vigorously sought after.

The Junior Engineers, Technicians and Scientists (JETS) program appears to be poised to join possible potent strategies for winning more girls for science and technology in Nigeria. The JETS concept was introduced into the educational system in 1987, primarily to encourage the development of science and technology culture among youth. The idea of JETS of Nigeria was first mooted by the second author and crystallised, with the help of her colleagues in the Popularisation of Technology and Science (PTS) Branch of the Federal Ministry of Education and some consultants, into a proposal which was submitted to government in June 1987. The accent of government to the introduction of this innovation was premised on the notion that today's youth will be spending half their adult lives in the science and technology dominated world of the 21st Century. The need to prepare and tool them for the future was considered a priority by government, and the JETS concept was seen as being in alignment with this goal. A JETS Planning and Implementation Committee (JETSPIC) was established to prepare the necessary groundwork for the effective take-off of the JETS program.

JETS seeks to encourage Nigerian youths to adopt the problem-solving behaviour of engineers, technicians and scientists. It encourages fabrication and copy technology. It strives to promote the development of creativity and the channelling of such talents to solving everyday problems in the immediate environment. The forum for the pursuit of these objectives is the JETS Club. Over 6000 such clubs, enrolling an average of 120 students, have been formed in schools and colleges in the 21 states of the country and the Federal Capital Territory of Abuja. About 30% of JETS Club members are girls.

Before the introduction of the JETS concept into the educational system, there existed science clubs which were extra-curricular outfits that focused on promoting students' interest in biology, chemistry and physics. These clubs had been on the scene for the great part of the fourteen-decade history of formal science teaching in Nigeria. The replacement of science clubs by JETS Clubs came about as a spin-off from the introduction of the JETS concept and also as a response to the provisions of the National Policy on Education of 1981, which injected introductory technology into the secondary school curriculum. JETS Club activities accommodate science, engineering and technology whereas Science Clubs looked narrowly at the three major component disciplines of science which to all intents and purposes was out of tune with the spirit of the National Policy.

JETS activities as 'bait' for girls

It has been observed that many girls are now signing up to be members of JETS Clubs in Nigerian secondary schools, a trend which has implications for swelling the ranks of the female scientists and engineers in the Nigeria of tomorrow. Data available in the Popularisation of Technology and Science (PTS) Branch, the National Secretariat of JETS, indicate that the proportion of girls to boys observed a 2% increase in 1990. There are high hopes that further increases will be recorded in the coming years. The question worthy of being addressed next is: "What is girl friendly about JETS activities that accounts for the increased enrolment of girls?"

Four issues stand out for mention. First is the institutionalisation of the Best Female JETS of the Year Award. This is a national award that goes with the elegant and prestigious Francis Gana Trophy, and which was presented by the President and Commander in Chief of the
Armed Forces of Nigeria on November 28, 1990. The award is made to the best female student enrolled in a pre-university institution that earns the highest aggregate points in the highly competitive National JETS Competition. The contest is conducted in three phases: Theory, Practicals and Oral. Six subjects are involved: Agricultural Science, Biology, Chemistry, Mathematics, Physics and Technology. The second, third and fourth position winners also receive prizes and honourable mention at the national level.

The selective recognition of girls is seen to be a strong factor of encouragement for girls all over the nation to join JETS Clubs. Bunmi Ogunedeji, a female JETS from Federal Government College, Calabar, who received an honourable mention, wrote to the National JETS Secretariat on her return to school that:

"... for the fact that we went to Yola (for the JETS Competition) and later Lagos, every girl in my school wants to join the JETS Club. When the students saw our JETS badges, they fell in love with it and were asking where it could be bought. Well, I was quite happy to tell them that the JETS badges are not for sale, but worked for by us."

Another factor of attraction is the nature of the projects that JETS are encouraged to undertake. These projects have their spectrum of focus on a range of topics that have relevance to solving domestic problems. For instance in 1990, the national theme for the project was "Indigenous Food Preservation Techniques". The girls were on excellent terrain here as the traditional Nigerian homes feature such techniques that have more or less been perfected by women. Consequently, many girls exhibited projects (more than in previous years). Projects on the design of equipment for preserving local foodstuffs, especially grains and vegetables, and improved methods of slaughtering, drying, smoking and canning food materials were displayed by girls. The boys also put up a good show.

The third factor is the motivating effect of the all-year-round national radio and television airing of the National JETS Project and Quiz Competitions. Every Monday at 6.30 pm, there is a network transmission of the competition by the Nigerian Television Authority to more than 30 million viewers. On Tuesdays and Saturdays at 2.30 pm, the Federal Radio Corporation of Nigeria (FRCN) broadcasts the quiz competition nationwide.

It is believed that the excellent performance of girls in the preliminary finals, quarter finals, semi finals, and the final stages of the competition is challenging other school girls and providing them with an impetus to elect to study science and join JETS Clubs in their schools. Noteworthy in this connection, is the performance of the all-girls team from Ogun State, winning the National Young Scientists Competition in 1987 and, in 1988, the girls went ahead to knock out highly rated teams in the preliminary and quarter finals. In 1990, all girls in teams from different states, especially Imo and Lagos, gave a good account of themselves, particularly in Maths and Physics. The weekly national airing of such wonderful performances by female JETS is a source of inspiration for female viewers at home. The winning of the national award by the female JETS from Cross River State for her project on the making of paper from Guinea grass also attracted good media coverage in October 1990. Taken together, these achievements by female JETS present a source of reassurance that girls in Nigeria can quite effectively hold their own in science and technology.

The fourth factor is the next to be mentioned. At the institutional level, JETS Club activities include symposia, fairs, study tours and field trips, quiz and project competitions, science and technology debates and essay competitions. In some schools, these activities are purposely designed to encourage female participation. Guest lectures presented by female scientists, career talks and counselling for JETS Club members given by female scientists, study tours or visits to industries where female scientists work, talks on the world's great female scientists, and the inter-school JETS debates between female and male club members, are among the many 'girl-friendly' activities that have presumably helped to win more girls for JETS.

Nurturing the 'captured' girls

Having won the girls over through JETS, sustaining their interest in science and technology is a major goal of the PTS Branch as well as the soon to be established JETS of Nigeria Implementation Committee (JETSONIC). Proposals are being prepared for the production of literature to provide enrichment materials in science and technology topics for JETS. Seasoned science educators and teachers are expected to prepare such materials, especially in those topics that are rated as very difficult to learn in Agricultural Science, Biology, Chemistry, Mathematics, Physics and Technology. It is envisaged that these enrichment materials will help to make the learning of science, technology and mathematics more meaningful and a lot more fun.

The JETS Forum is another avenue for providing further motivation for all JETS generally and female JETS in particular, to continue being in JETS and aspire towards science and technology based careers. This magazine is expected to go into circulation by the middle of 1991. A number of other proposals are on the drawing board for sustaining the interest of female JETS, as well as assisting them to do well in their school examinations in the sciences and mathematics.

Conclusion

This paper has broadly looked at ways in which the JETS program has been of value in winning more girls for science and technology in Nigeria. Although the program is new, and its effectiveness has not been formally evaluated, the indications are that it is serving the useful purpose of promoting scientific literacy for women, and much more. It is, for instance, building up a pool of young female engineers, technicians and scientists that will be in the forefront of accelerating science and technology development in Nigeria. It appears that the newly formed National Association for Women in Science, Technology and Mathematics (NAWSTEM) will, in the near future, record a phenomenal membership as a result of the introduction of the JETS concept into the school system.

It should be mentioned in conclusion that JETS is a program for all youths in Nigeria, male and female alike. The impact of the program to the 'world of the boys' is not being
subordinated, and a deliberate position is not taken to diminish their efforts. Our findings show the remarkable effects the program has had on the attitude of boys toward science and technology. We have noticed, however, that the female JETS are benefitting from the program in an outstanding way, and we unequivocally conclude in favour of the position that JETS is a potent tool for winning more girls for science and technology in Nigeria.

References


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100th Anniversary of the Founding of MNU
The German Association for the Promotion of Mathematics and Science Teaching
by Prof. Hans-Jürgen Schmidt, Dortmund University, Germany

The Association's 82nd annual meeting, held in Göttingen 25-27 March 1991, coincided with its 100th anniversary. The MNU was founded in Braunschweig, October 1891. This jubilee is an occasion to remember the school situation in Germany in the 19th century and how science teaching came to be accepted in our state schools.

At the beginning of the 19th century there were mainly two types of schools in Germany. The majority of the school population attended the 8-grade Volkschule. Those who aimed at entering university later on enrolled in Gymnasien (grammar schools). These schools emphasised humanistic education, and Greek and Latin played an important role in the curriculum. There had already been attempts in the 18th century to teach "practical knowledge and skills" in higher education, too.

This development led to a new type of school, the Real schule. As the name indicates, these schools taught the realities (science and mathematics). The original idea was that the Realschulen were to prepare students for higher professional qualifications which did not require academic studies. Part of these schools, however, took quite a different course. They extended the number of school years to be completed and became comparable to grammar schools. Many supporters of humanistic education disapproved of this development, downgrading the Real schule as Nützlichkeitskramschule a long word with connotations of "grocer's shop" and "Jack of all trades". Other educationalists were apprehensive of this turnover of the whole system, alarmed that science education might breed revolution (Umwälzungsmenschen). Scientific ideas had indeed turned 19th century life and views of the world at large upside down. Many scientists were atheists - they no longer believed in the world being God's creation. It was the industrial revolution in Germany that gave the Realschulen the final push ahead. They began to prosper and those that were comparable to grammar schools became called Realgymnasien and Oberrealschulen. From 1870 on, students were entitled to pass their Abitur (final examination) at these schools thereby enabling them to read mathematics, sciences and modern languages at university. From 1900 on these students gained access to all departments of academic studies. Still, the Realgymnasien and Oberrealschulen remained a minority compared with the humanistic grammar schools that represented two thirds of all schools of higher education in Germany in 1905. The sciences were thus introduced into higher education from roots, whereas in Britain, the private public schools were the first to teach science.

However, at the turn of the century, the debate over arts and humanities versus realities and technology had not yet come to an end. Supporters of science education raised the question whether or not general culture can be arrived at by studying science. The Realgymnasien and Oberrealschulen did not mean to end up as Nützlichkeitskram schulen.

That was the situation in 1891 when the MNU - Association for the Promotion of Mathematics and Science Education - was founded. At the annual meetings of the new association this problem of science and general education was eagerly discussed. One of the outstanding speakers at these meetings was the German educationalist Georg Kerschensteiner. His lecture at the 1913 conference in Munich was later published in a booklet under the title Wesen und Wert des naturwissenschaftlichen Unterrichts (essential features and values of science teaching). Today Kerschensteiner is considered as the "father of the vocational schools".

100 years have passed since MNU was founded. We now take for granted that the sciences are fully integrated into the school curriculum. The question that was raised 100 years ago when MNU was founded is still relevant - what do students and society at large benefit from biology, chemistry, physics and mathematics teaching? For a century now, MNU meetings have provided the only national forum for the discussion of questions relating to science and mathematics teaching. At present, MNU has about 6000 members and organises yearly national meetings and regional conferences.

In 1970 the Gesellschaft Deutscher Chemiker (GDCh) founded the Fachgruppe Chemie-unterricht (Education Division). This body has 750 members at present. Similar divisions were formed from the Deutsche Physikalische Gesellschaft and the Verband Deutscher Biologen. In 1973 the Gesellschaft für Didaktik der Chemie und Physik came into being, and now has 300 members.

While MNU and the Education Divisions have attracted teachers mainly from the Gymnasien, the GDCCP comprises to a large extent persons who taught or were educated at one of the Pädagogischen Hochschulen (teacher training colleges).
International Council of Scientific Unions
Committee on the Teaching of Science

Report for the period
1 May 1990 to 31 March 1991
by Professor Joseph P Stoltman, Secretary, ICSU-CTS

Introduction
The Committee on the Teaching of Science (CTS) was established as an Inter-Union Commission in 1961, and was modified to a Scientific Committee in 1968. Its principal goals are (1) to develop and enhance, on an international scale, the teaching of science at all levels of education and training; (2) to cooperate with other organisations to further all aspects of the teaching of science; and (3) to facilitate cooperation between the Teaching Commissions of the International Scientific Unions.

Membership
Eighteen scientific union members of ICSU subscribe to and have representation on the Committee on the Teaching of Science. Seventeen Union members subscribed to ICSU-CTS in 1989. COSTED and ICASE are affiliate organisations.

Scientific Meetings
CTS sponsored the Harare Generator in Zimbabwe during early 1991. Additional meetings in Brazil, China, Hong Kong, and France, and organised by affiliates or Teaching Commissions of Member Unions, had CTS representation.

The Harare Generator
A major activity of CTS during the past year was the Harare Generator on the Preparation of Innovative Teaching Materials for Science Education. The Workshop was held in January 1991 and involved approximately 60 participants with responsibility for science education from 11 countries in Africa. Participants included science teachers, trainers of science teachers, and scientists. During the Generator the participants worked in teams to 'generate' classroom materials for use in African schools. In addition to print materials, the teams designed and built scientific apparatus for measuring and recording the results of experiments. The equipment used by teachers in their lesson ranged from classroom-made balance scales to microcomputers. The Workshop was co-sponsored by the African Biosciences Network, Unesco, FASE, The British Council, the Rockefeller Foundation, and the Commonwealth Foundation. The Generator was a followup to the Bangalore Conference on Science and Technology Education and Future Human Needs held in 1985. ICSU-Unesco Pilot Project in University Science Teaching
CTS continued its co-sponsorship, along with Unesco, of the Pilot Project on University Science Teaching. The Project has two major goals. First, it is a demonstration of how universities can pool resources to develop teaching materials useful for basic courses. Second, the project is demonstrating how science classroom materials and equipment may be readily produced by university teachers and technicians. The Project is progressing with science curricula in biology, chemistry, and physics at university centres in Thailand. It is planned that the newly developed courses in the disciplines will serve as prototypes for the development of science survey courses offered for non-science major students in post-secondary educational institutions in developing countries.

Science and Mathematics for Future Elementary Teachers
CTS and ICME are continuing collaboration on the Science and Mathematics Education of Future Elementary Teachers Project, sponsored by Unesco. Carried out by an Elementary Science Sub-Committee of CTS, the activities of the project have resulted in a 1990 publication entitled Science and Mathematics Education for Future Elementary School Teachers. The Project continues to meet the needs of Unesco and numerous nations through its international teacher workshops and publications.

Microprocessors and Microcomputers in Science Teaching
The introduction and use of microprocessors and microcomputers in science and technology education was initiated in 1985 in Southern Africa. Two subsequent programs, in 1987 and 1988, were successful in disseminating knowledge of and skills in using microcomputers. A followup workshop for Southern Africa is in the planning stages.

Locally Produced Scientific Equipment
The low-cost, locally produced scientific equipment produced by CTS focuses almost exclusively upon science education in the developing world. The aim of the project is to train university and college faculty to design and build the equipment necessary for student experiments. The project has developed specifications for low cost laboratory equipment, has trained science educators in the production of the equipment, and developed competencies among staff persons in the maintenance of the equipment. Collaboration between CTS, WHO, and IUB is being considered as a means to expand this project. The work on this project was initiated and continues in India, and is currently underway in Brazil, Puerto Rico, The Philippines, Jordan, francophone Africa, and most recently southern Africa as a result of the Harare Generator. These CTS activities are concerned with and address problems associated with the production of scientifically sound, low cost materials for teachers and trainers of teachers in the developing world.
Education in Global Change

The Education in Global Change Project is in its second phase of curriculum materials development. The Project has been designed to produce classroom materials for secondary science students that incorporate recent scientific data pertinent to global change research. Science educators and global change scientists participated in the writing of materials in June 1990. Four units have been distributed to science teachers, science educators and scientists for review. The materials development team met for a second writing session in May 1991 to design and draft three additional instructional units for classroom trials. It is planned to initiate teacher training workshops in various parts of the world in 1992 as a third phase of the project.

Ethics Issues in Science Education

Plans are being made for a workshop on teaching about ethical problems in science with the intention to reach a diverse, international audience. The team planning the workshop is made up of scientists and science educators who have a commitment to teaching about ethical issues in science. Pending the availability of funding, the workshop is tentatively scheduled for summer 1991.

Education in Natural Disasters Reduction

This project is underway to complement the International Decade for Natural Disaster Reduction. The rationale for initiating the project is based upon the lack of information available on natural disasters in science curriculum materials. A large proportion of the global population is at risk from natural hazards; yet little has been done to inform school students about natural disasters. The first phase of the project is being planned as a handbook for teachers, followed by the development of prototype teaching units.

Publications

Science and Mathematics Education for Future Elementary School Teachers, a joint ICSU CTS-ICME-Unesco publication, was issued in December 1990. It is the first of several monographs to be prepared as a result of the activities of the Science and Mathematics Education of Future Elementary Teachers Project. Several additional publications have been prepared or in planning stages during the last year. Science Education and the Computer Age: Applications, Resources and Standards is a handbook devoted to information processing, microprocessors and computers in science teaching, being prepared by a subcommittee of CTS. It will be made available free to science teachers and students worldwide.

The preparation of a volume of selected papers from the 1985 ICSU CTS Bangalore Conference on Science and Technology Education and Future Human Needs is being considered. The papers of the Conference were initially published as nine volumes. It is deemed important by CTS to extract the papers that meet particularly critical needs in science education and republish them in a single volume for greater access by science educators.

The initial four instructional units developed by the Education in Global Change Project have been distributed for review in draft format. The writing, formatting, and peer review of the units are the initial steps toward publication and dissemination.

New Areas of Interest

There are two areas that CTS is examining for possible future activities. The first is in conjunction with the ICSU-UNDP project proposal entitled Strengthening Science Training and Research in the Third World. The CTS component of the project would involve the development of prototype teaching units on interdisciplinary science at the tertiary level of education. The second is the concern with the public understanding of scientific concepts. These projects are concept papers presently and, if pursued, will take form over the next year. In addition, CTS is cooperating with the UNCED working party on Environmental Education and plans to participate in the future activities of the project.

Conclusion

CTS continues to serve a vital function within ICSU, both in its coordination of activities sponsored by the different scientific unions, as well as the initiatives that come from the Committee. The identification, coordination, and preparation of scientific research information for science education at all levels remains its major function.

A Report on the Annual Meeting of NVON
The Netherlands

by Jan Hendriks, ICASE European Representative

On the weekend 22-23 February 1991, the Dutch Association (NVON) organised its Annual Meeting in Utrecht, in conjunction with the National Education Exhibition. A feature of the meeting, therefore, was the focus on educational equipment, including textbooks and computer assisted instruction.

Highlights of the meeting, comprising a number of lectures and demonstrations, workshops and symposia, included (1) a session by Peter Nicolson, University of York, UK on Salters A-Level Chemistry, and (2) a lecture by Ellen Hirbel and Ole Bostrup, Espelergaarde, Denmark on "Science lessons for less clever secondary school children: a phenomenological approach based on experience with handicapped children". At the annual business meeting, Bert van Beek was elected as Chairman, NVON, to succeed Erik Jongejan who has held the position of Chairman from 1985 to 1991. Erik Jongejan organised a very successful Saturday evening and Sunday meeting for biology educators from Belgium, Denmark, France, Germany, The Netherlands and the UK.

An excellent conference buffet was organised in the National Museum.
Microcosmos: A Necessary Approach for Biotechnology Education

Adapted from Microcosmos News, Summer 1990

If we assume that effective ongoing education is central to the growth and development of the biotechnology industry, the question remains: What is the best way to achieve this? While there continues to be outstanding programs, a new and necessary frontier must be developed: a pre-biotechnology curriculum.

Whether we truly are to develop an educational appreciation and involvement in biotechnology will be determined by the answers to questions such as these: To what degree have we prepared classroom teachers and their youngsters to be comfortable with the foreign world of microbes? Are classroom teachers truly integrating hands-on, fun-oriented activities involving microbial themes into their life science curricula? To what degree are industry and educational advocacy groups pushing for more process skills development in life science classrooms? Are we teaching youngsters to observe, classify, synthesise data, cooperate, and think.

It is a mistake to think of biotechnology or applied microbiology as a discipline to be first taken up at a university, or even in an advanced high school class. Rather, it grows out of a continuum that must be started and maintained much earlier.

Any corporation or government sending a representative who has stated fear of flying, and who has received little preparation for his or her assigned country, would be considered irresponsible or careless. Yet this is precisely what we do in our approach to biotechnology education. We are not taking time to make school-age children in particular, and the public at large, comfortable with the fascinating, albeit alien, realm on which biotechnology is based - the ubiquitous universe of microbes.

Microbes are still thought of principally as disease-causers. People have fears that have been carried since the plagues of earlier centuries! They have absolutely no exposure to the fact that microbes are a major positive influence upon our survival and that of the planet.

Even something so basic as the source of oxygen we breathe is unknown to students, and seldom considered by teachers. Few are exposed to the fact that most of our oxygen comes from oceanic microbes.

Microcosmos is a curriculum development, teacher-training workshop and exhibits program, designed to make teachers more comfortable with the microbial world, and simultaneously to create for young students the necessary enthusiasm and confidence in science. It features an International Advisory Board and a coordinating Team as part of the Science Education Program at Boston University, USA.

Microcosmos has developed the Microtrek: Explorations of Microbial Space curriculum, featuring over 30 hands-on introductory activities. Teachers in more than 15 American states are currently using portions of it. In its timeline activity, Microtrek points out that all of the world’s greatest “inventors” were “born” more than 600 million years ago! Indeed, every fundamental activity we need for survival was invented by microbes or microbial consortia long before the first macroscopic creatures.

These inventions, this vast foreign landscape, must be brought to the schoolchildren of the world if biotechnology education is truly to take root and produce the future scientist seedlings upon which not only the biotechnology industry but mankind will depend.

From Microcosmos Update
March 15, 1991

A Microcosmos workshop is planned for Barcelona, Spain in November. The Director, Douglas Zook will be travelling to New Zealand to conduct on-site Microcosmos and biology explorations in April 1992.

For more information
Contact Microcosmos Project, Boston University, School of Education, 605 Commonwealth Avenue, Boston, MA 02215, USA.
Enhancing Elementary Students' Attitudes Toward Science

by William C. Kyle Jr, Ronald J. Bonnstetter, Maria A. Sedotti & Donna Dvarskas

In 1987, the Cheshire Public Schools initiated a science curriculum review. Teachers, parents, and students recognized that the existing textbook-based elementary science program was a dismal portrayal of such a dynamic discipline. There was community consensus that reading about science and acquiring scientific vocabulary words was not the same as doing science. A mandate was issued to identify, develop, implement, and evaluate a science curriculum that addressed the current goals in science education. Selected Delta Science Modules were identified as the focal curricular resources around which local curriculum development could be initiated. The first year evaluation supports the fact that Cheshire's ScienceQuest program is most successful. Between 50% and 88% of the students at any given grade level indicated that science was their first or second favourite subject in school. The nature of the science taught does make a difference! Administrative support and the implementation process are also keys to success.

Introduction
The 1980s were exciting and challenging times for educators. Adding to the excitement was the realization that students who entered kindergarten during the Fall of 1988 will be the first high school graduates of the 21st century. Thus, responding to the question, "Are students being provided with the scientific and technological literacy essential for life as productive citizens in the 21st century?" is a curricular imperative for the reform era of the 1990s.

In March of 1987, the Cheshire Public Schools established a K-12 science committee to address the above question. Internal audits revealed a local situation that paralleled the recent image portrayed by "The Science Report Card . . . " (NAEP, 1988). The audit revealed that: the elementary program was antiquated in nature, lacked continuity, and coordination; the process-approach was not used often; elementary teachers did not have adequate resources to teach science; and, teachers did not feel they possessed an adequate science knowledge base and were not comfortable teaching science. Teachers were not familiar with the current goals in science education (NSTA, 1982).

During the next six months the committee developed: a mission statement; a rationale for teaching science: program goals and objectives; a plan for identifying, developing, and piloting curricular materials; a rationale for staff development and program implementation; and, the evaluation component for the first year pilot. The committee decided to begin the curriculum revision process at the elementary level to allow for subsequent curriculum development and continuity at the middle school and high school.

During the 1987-88 academic year, Cheshire's ScienceQuest program was piloted in selected K-6 classrooms. A major goal for the first year was to enhance students' attitudes toward science. Thus, students' attitudes were assessed at the completion of the first year of the pilot. Concomitant goals were to enhance teachers' awareness of the current goals in science education; science background so that curriculum development efforts would be relevant and implementation efforts successful; and conceptions of teaching and science (see, for example Kyle, Abell & Shymansky, 1989; Kyle & Shymansky, 1989, Osborne & Freyberg, 1985).

The Process of Initiating Change
There are some common characteristics associated with the process of initiating change and, ultimately, improving schools. The innovation implementation model used in Cheshire was also utilised in Richardson ISD, Texas, where the implementation of different curricular materials produced similar attitudinal enhancement among students (see Kyle et al., 1988a, b; in 1989 Richardson was recognised as an Elementary Science District-wide Exemplar in NSTA's Science Education Search for Excellence).

Penick and Yager (1983) report that exemplary programs are designed to be excellent. Such programs do not rely upon routine textbook selections. A considerable amount of time is spent on developing the curriculum, organising how it will be presented, and encouraging teachers to work as teams. Thus, teachers are involved in staff development activities over several years, including summers.

The nature of staff development activities is so important that Berman and McLaughlin (1978) concluded that
the major factor affecting success of staff development efforts related to educational innovations was the administrative support of such endeavours. It is well documented that staff development is an essential component of the curriculum development, implementation, and maintenance process (Fullan & Pombrett, 1977; Hall et al., 1975; Hall & Louches, 1976; Kyle, Bonnsterter & Gadsden, 1988a; Kyle & Sedotti, 1987). Additionally, exemplary programs start with, and continue to use, an ongoing assessment of teacher, student, and program needs to guide future staff development.

Cheshire’s Science Committee recognised that exemplary science programs are the result of effective organisation, planning, and staff development initiatives. Thus, they developed a plan to ensure that ScienceQuest was well articulated and well coordinated; integrated a balance of science processes and concepts; provided students with opportunities to identify and solve problems; enhanced higher cognitive processes and skills; went beyond the mere possession of information to application of the concepts; and, included societal issues.

During the summer of 1987, the science committee identified curricular materials appropriate for pilot testing in grades K-6 during the 1987-88 academic year. Selected Delta Science Modules were identified as the focal curricular resources (see Kyle & Kane, 1988). Additional modules and activities were developed locally to integrate a focus on the application of scientific concepts, as well as science-technology-societal issues. The modules and activities were sequenced to ensure a balance between life science, earth science, and physical science across each grade. The initial piloting of the ScienceQuest program was intended to determine: the success of the modules, activities, and materials and whether they should be maintained in the program as curricular identification, project development and piloting continues; whether modules and activities need to be revised to address district, teacher and/or student needs; as well as, to identify curricular areas for further local curriculum development to address effectively the district's mission statement, rationale, goals and objectives.

Thus, Cheshire’s Science Committee sought to ensure that ScienceQuest would meet the standards for excellence cited by Project Synthesis and the National Science Teachers Association (Harms & Yager, 1981; NSTA, 1982). In addition to the curriculum identification, implementation, and evaluation efforts that have been initiated, perhaps the most important component of the entire curriculum revision process is the staff development that teachers received in conjunction with program development and implementation (see Table 1 for a description of the staff development associated with the ScienceQuest project).

ScienceQuest: First Year Results and Discussion

After only one year of the pilot project, ScienceQuest students possessed significantly enhanced attitudes toward science when compared to their counterparts in control classrooms, as measured by the Preferences and Understandings attitude questionnaire (see Table 2). The data support the fact that elementary students have a preference for inquiry-oriented, process-approach science.

Frequency analysis reveals that over 60% of ScienceQuest students selected science as their first or second favourite subject in school. Only 35% of the control students indicated similar preferences. This dichotomy is further dramatized by the fact that only 6% of ScienceQuest students selected science as their least favourite subject in

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for outstanding contributions to international science education

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This award honours individuals who have made a significant contribution to international science education through their involvement in international activities at the local and regional levels

**ICASE Association Award**

This award recognises individuals who, within their science teacher association, have made a significant contribution to the international activity of their association

Contact Dr Jack Holbrook, Executive Secretary ICASE
Royal Society of Chemistry, Burlington House, Piccadilly, London W1V 0BN, UK

23
TABLE 1
SCIENCEQUEST STAFF DEVELOPMENT

Each month from September to November and January to May, there were grade level meetings for the pilot teachers. The staff development sessions provided pilot teachers the opportunity to:
- delve into the history and philosophy of science education in order to gain an appreciation of the goals associated with hands-on, process-approach science at the elementary school level.
- study the characteristics of the curriculum development initiatives of the 1960s and 1970s, as well as attributes of their success as measured by student performance.
- investigate the current goals identified for science education at the national level. Instructional strategies to address the goals in elementary science classrooms were also discussed and modelled.
- participate as active learners in the activities associated with each module that they would instruct in their classroom. During these model instructional sessions, teachers were able to make preliminary revisions or modifications to the organisation of the modules to ensure effective implementation. At the completion of these sessions, teachers ordered any additional equipment or resources that they needed to effectively instruct the module.
- receive content updating to enhance their science background in areas correlating with eventual instructional responsibilities. The content updating was provided as needed and requested by the pilot teachers.
- share information regarding the nature of curriculum implementation, the need for revision/modification of specific modules, and modes to resolve any difficulties that may have arisen. Teachers prepared and submitted written evaluations for each module. The evaluation included, but was not limited to, the pilot teacher's recommendation to keep or delete the module from the curriculum, as well as a detailed report of any adaptations made to the module to achieve the desired outcomes with their students.

During the summer of 1988, pilot teachers worked with the science committee to continue the process of identifying curricular materials, revising modules based upon pilot teacher evaluation, identifying materials and equipment necessary for instruction, and initiating the process of local curriculum development. A goal for second year pilot teachers is to develop a strand of curricular materials and activities with a focus on science, technology and societal issues and/or applications of scientific concepts that can be integrated into the curriculum.

The second year of the ScienceQuest implementation (1988-89) had approximately 40 new teachers piloting the program and participating in the sequence of activities associated with the first year staff development plan. In addition, work related to the development of a criterion referenced evaluation system to assess students' mastery of science processes and concepts began during the 1988-89 academic year. The formal evaluation of students' attitudes was continued with a longitudinal assessment of students in first and second year ScienceQuest classes compared to control classes completed in May 1989.

A formal assessment of student achievement will be a part of the second year pilot plan, as well as an assessment of teachers' concerns and levels of use of the program in compliance with the Concerns-Based Adoption Model. The implementation efforts undertaken, and planned for the future, will ensure that Cheshire's ScienceQuest curriculum will be a dynamic, rather than static, elementary science program.

TABLE 2
ANALYSIS OF VARIANCE FOR PREFERENCES AND UNDERSTANDINGS: TOTAL SCORE

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>MS</th>
<th>F</th>
<th>SIG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between Groups</td>
<td>1</td>
<td>3967.8</td>
<td>33.8</td>
<td>.000*</td>
</tr>
<tr>
<td>Interaction</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group x Gender</td>
<td>1</td>
<td>0.65</td>
<td>0.006</td>
<td>.941</td>
</tr>
<tr>
<td>Group x Grade</td>
<td>4</td>
<td>359.2</td>
<td>3.3</td>
<td>.011*</td>
</tr>
</tbody>
</table>

* p < 0.05
school compared to 15% of the control students.

Research indicates that as students progress through school that their attitudes toward science decrease and they appear to be unenthusiastic about the value and personal relevance of their science learning (Huftile, Rakow, & Welch, 1983; NAEP, 1978, 1988). Students in the control group appear to reflect this trend when the results for their combined first or second favourite subject preferences are viewed. Forty one percent of the control students in grades 2 and 3 select science as their first or second favourite subject. This percentage drops to the 30% range by the time students reach 5th and 6th grade. Similarly, 2% of 2nd and 3rd grade control group students select science as their least favourite subject, while 20% to 28% of 4th, 5th or 6th grade control group students make such claims. However, over 50% of the ScienceQuest students at each grade level selected science as their first or second favourite subject. The percentage peaks at 3rd and 4th grade with 83% and 88% of the students making such claims. Obviously, when 50% to 88% of the students at any grade level, and 63% of the students across all grades, have such positive images of a program, it is a tremendous success!

The data also reveal that students in ScienceQuest classes wish they had more time for science (59% vs 40%); are more likely to recognise that the science they study is useful in their daily lives (74% vs 68%) and will be useful to them in the future (68% vs 59%); view their science experiences as fun (84% vs 62%), interesting (88% vs 70%), and exciting (71% vs 52%), all while fostering a feeling of success (60% vs 49%) and curiosity (71% vs 67%).

The results presented herein contrast sharply with national norms in the United States (NAEP, 1978, 1988). The positive attitudes of students in the ScienceQuest program can be attributed to the nature of the program, in conjunction with the staff development that teachers received to implement an effective science curriculum. The nature of the science taught does make a difference! In addition, when teachers are provided with appropriate staff development, they are able to portray an image of science that is fun, exciting, and interesting. Many teachers are enjoying the teaching of science as it should be for the first time in their careers, and they have the support required to do so!

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**About the Authors**

William C Kyle, Jr is an Associate Professor and Director of the School Mathematics and Science Center at Purdue University, USA. Ronald J Bonnstetter is an Associate Professor and Director of Secondary Science Education in the Center for Science, Mathematics, and Computer Education at the University of Nebraska - Lincoln, USA. Maria A Sedotti is a PhD candidate in the Department of Curriculum and Instruction at The University of Connecticut, USA. Donna Dvarskas is Assistant Superintendent in Cheshire Public Schools, Connecticut, USA. They are the recipients of the 1989 Science Teaching Achievement Recognition Award (STAR), sponsored by the American Gas Association and presented by the National Science Teachers Association (USA).
Native American Elders Teach Science

by Patricia Nelson & Claudette Bradley

Helping all students succeed in science is one of the hottest topics in US education today. Many states are forecasting a trend that is now a reality - schools composed of a majority of culturally and racially diverse students.

This composition creates a unique opportunity for children to live and learn together in new and exciting ways. Science teaching methods which reflect this diversity can help teachers bring good science into the classroom, spark student interest and validate the "ways of knowing" of all cultures.

At Denali School in Fairbanks, Alaska, an innovative project has been implemented to help students blend Native American culture with science and mathematics by using the knowledge and wisdom of Native Elders. Students study the forces involved in flying a plane (gravity, lift, thrust and drag) by exploring the rich oral tradition of their ancestors and by the direct observation of nature.

Lessons may start with a "Bird Walk" and listening to stories of birds told by Native Elders in the community. Students learn from such stories that ideas from their own cultures can be "very good" and "thoroughly reliable". Native cultures have a vital oral tradition drawn from the direct observation of natural phenomena.

Scientific knowledge and wisdom of the world is embedded in stories told by the elders. When students feel their culture is validated, learning science can become a richly rewarding by-product.

At Denali School, lessons on flight begin with the study of birds, like the Eagle, Crow, Raven, Duck, Goose, and Swan. Students are assigned to a small group to gather folklore, native stories and scientific data from books, technical reports, native elders and other wildlife specialists to find out such topics as how high a bird flies, how much it weighs, how wide is its wing span and what are its habits.

Stories and information are presented in song, written reports, dramatic skits, or charts. Students then create a book on Flight by writing their observations of birds during their Bird Walks, drawing pictures and summarising stories told by the visiting elders.

When all the facts are gathered, students create a bulletin board with a graph of the altitude on the vertical axis and the name of each bird on the horizontal axis. The class plots ratios of body weight to wing span, as well as body dimensions to wing span.

From this information, students draw conclusions about how the ratio of wing span to body dimensions impacts flight. The ratios of wing span and the body shape of various airplanes can also be placed on the bulletin board next to the bird graph, with the altitude on the vertical axis and the names of planes on the horizontal axis. Students draw conclusions about the dimensions of the plane and the height it is able to reach by comparing this data gathered on birds.

A variety of follow-up activities can extend lessons and spark student interest. Students can design and make their own airplanes of various materials, hold a contest on how high and how far each plane can fly, or draw the flight curves with the height and distance travelled. A field trip to the airport, interview with a native pilot, or using a flight simulator on the computer will also enable them to enjoy learning science with their friends. Students can enjoy plotting a course from their hometown to some distant place. They can learn to read latitude and longitude, as they plan to avoid mountains and turbulent areas and gain facility in using a map.

Even Bernoulli's principle becomes simple to grasp when students gather their own data. This principle also operates in bird flight.

All cultures offer explanations of such natural phenomena. The Indian people of North America refer to the eagle as the Thunderbird. As the Thunderbird descends in the air he is also bringing the Great Spirit to the earth. When the eagle descends in the air, he bends his wings and makes a thundering noise in much the same way a jet does on landing (when the airplane descends in the air, the flaps are lowered, so that the airplane will descend).

A simple paper demonstration can illustrate the Native American's knowledge of Bernoulli's principle. By holding a light piece of paper about 3/4 inch by 3 inches against the chin under the lower lip and parallel to the floor, the paper will rise when the students blow over the top surface of the paper. The air blowing across the top of the paper moves faster.

It is through imitating models in simple hands-on experiments that students learn to reason about the principles of gravity, lift, thrust, and drag. Students become excited when they use this knowledge of everyday
life to engage in the process of scientific thinking.

Often students learn that the science is disembodied knowledge that cannot be questioned, knowledge from a scientific authority whose author is inaccessible. Through helping students think out loud about drawing conclusions from their own collected data, knowledge becomes more than the private property of teachers or textbooks.

Any teacher with time and desire can incorporate the rich traditional stories and knowledge that has existed in any culture into a science unit. By teaching science through the use of elders, oral stories and natural observation, students are encouraged to make the knowledge personal and individual. Science which stems from the authority of textbooks is revealed to be human.

A different sort of scientific authority emerges, based on personal experiences and acknowledging and nurturing the viewpoints of students' own cultures. Including cultural perspectives helps students engage in their own process of thinking, evolve their own patterns of scientific process, and experience positive feelings about themselves and their cultures. The possibilities are endless!

About the Authors

Patricia Nelson is based at the University of Nebraska in Lincoln, Nebraska, USA; Claudette Bradley is based at the University of Alaska in Fairbanks, Alaska, USA.

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LOW-COST SCIENCE AND TECHNOLOGY MATERIALS

Published by Unesco Division of Primary Education
Literacy and Adult Education and Education in Rural Areas
Unesco, 7 place de Fontenoy
75700 Paris, France

LOW-COST SCIENCE AND TECHNOLOGY MATERIALS AT THE SENIOR MIDDLE SCHOOL LOWER GRADES LEVEL
(Examples of National Initiatives of Democratic People’s Republic of Korea, People’s Republic of China, People’s Republic of Chile and Brazil)

As a followup to an inter-regional workshop in Korea which met to promote the development of innovative, low-cost materials to assist teachers to implement science and technology education in pre-primary, primary and secondary curricula, Unesco has published a series of illustrated guidebooks which show examples of low-cost materials made in the Democratic People’s Republic of Korea, People’s Republic of China, and in Brazil. The three books focus on low-cost science & technology materials at (1) Kindergarten Level; (2) The Primary School Level; and (3) The Senior Middle School Lower Grades Level.

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ICASE Research Seminar on Chemistry and Physics Education
University of Dortmund, Germany
10-12 June 1992

This symposium on empirical research in chemistry and physics education will focus on the methodology of empirical research in this field.

Proposals of about 3 pages should include title, background, method, results, discussion, implications for research and teaching, and references and should be sent to the contact above no later than August 31, 1991.

Contact: Prof Dr Hans-Jürgen Schmidt
University of Dortmund, Department of Chemistry
Otto-Hahn-Straße, 4600 Dortmund 50, Germany
The Questioning Technique in Science Teaching

by Sonia Williams
Science Department
Shortwood Teachers College, Jamaica

The typical environment of a primary school student is complex as it is composed of a number of factors which interact with each other to varying degrees. The factors include limited equipment and resources, large numbers of students in each class, classroom buildings with blackboard separations so that it can accommodate more than one class, inadequate library facilities, examinations such as Common Entrance Examinations and the National Assessment Program, neglected physical plants, the teacher, students and their peers.

The most important factor in nurturing students in the primary school environment is the solitary teacher. One challenge that faces us as teachers, comes from allowing students to be active, enquiring learners. This goal can be achieved if we perform appropriate teaching techniques. This paper focuses on questioning technique.

Situation 1
Questions introduced with the pairing of some scientific phenomena can instill a sense of wonder or a spirit of inquiry when they are presented at the beginning of a lesson. Pam was a teacher of a fifth grade science class. She placed a glass filled with water on a table in full view of all her students. She then placed a pile of coins next to the filled glass and asked her students, "How many coins will this glass of water hold without spilling any water?" At first, the students were quiet. Then there was noise as many students started guessing. One eager boy came forward and the teacher allowed him to add the coins. The boy kept adding coins; as many as fifteen, before the water spilled. He was astonished as well as the rest of the class. Their guessing seemed wild in comparison to the revelation that the filled glass could hold so many coins. The students held discussions on various aspects. They wanted to know about the volume of water, the size of the coins, the size of the container, the volume of the container. One student mentioned that he observed bubbles rise to the surface each time a coin was dropped in the glass.

Situation 2
The Grade 4 Curriculum (1980) produced by the Ministry of Education, Jamaica, focuses on green plant parts and their functions as well as a food test using iodine to detect starch. One way to introduce the concept that plants need materials to make foods would be to ask, "What things do green plants need to make their food?" A discussion with primary school teachers revealed that students are most likely to respond with 'water' and 'soil', though this latter response is not entirely correct, and that they are hardly likely to respond with 'light'. Explanations suggested by these teachers revealed that students do not associate sunlight with a form of energy. The follow-up activities that teachers must engage in should serve to assist students in understanding that light is a form of energy which plants require in order to make food.

Situation 3
When students are asked "How do plants get water?", some responded, "through their leaves". An examination of the cultural context enabled us to understand that response. In common Jamaican language we say, "water the plants". No one says, "water the roots". Furthermore, these students observe that when people water plants, the focus appears to be on wetting the leaves. This they also experience when it rains. Students can become baffled and confused and may even perceive science as contradictory and difficult. It is our task as science teachers of Primary School children to help them to accept the fact that their theories, the evidence they obtain from their senses, and even everyday language, may be wrong or incomplete.

Situation 4
In showing students how to classify a group of non-living things, Mary, the teacher of a fifth grade class asked, "What is the shape of the ball?"
Alex: "Circle, Miss."
Teacher: "No."
John: "Square, Miss."
Teacher: "Anyone else? Come on, someone must know the answer."
Marsh: "Round, Miss."
Teacher: "Yes, but that is not the answer that I am looking for."
Several students: "Me Miss, me Miss." (students shouting and raising their hands)
Simon: "A sphere, Miss."
Teacher: "Yes, Simon, you are correct. Did everybody hear what Simon said?"
Chorus: "Yes, Miss."
Teacher: "What is the shape of the ball?"
Chorus: "A sphere, Miss."
Contrast this follow-up by the teacher with an episode from another teacher who asked the same question.
Teacher Harrison began her lesson by asking, "What is the shape of the ball?" Students gave various responses. Then she invited students to do an activity in order to find out. Students were placed in groups and received instructions which indicated that they should trace a particular ball on paper, observing the edge, and that they should measure several distances around the ball. These are some of the
responses the groups arrived at.
"It is round and it is hard. When I put a piece of string around it and remove the ball, the shape is a circle."
"The edge is curved all the time. It is a circle."
"When I traced the shape of the ball, I got a circle."
Teacher: "You have all agreed that the edge of the ball is a circle. Where is the middle of the ball?"
Marcia: "Out here, Miss" (pointing to a specific spot on the outside).
Joe: "Inside, Miss."
The teacher then cut several styrofoam balls in halves instructing students to make horizontal and vertical measurements from the edge to the middle. At the end of this activity, students learned that the edge and the middle are used to describe spheres and that the vertical and horizontal distances between the edge and the middle were similar.

Convergent questioning focuses on eliciting a single right answer. When convergent thinking is followed up by guessing (what the teacher is thinking as observed in Mary's class), it sometimes places the student in an uncomfortable position. This situation may result in breeding fear of answering, at the risk of being wrong. In addition, convergent questioning can inhibit productive thinking as shown in Mary's class.

How can a teacher introduce divergent questioning in a science lesson? After having worked with batteries and bulbs you might ask, "How many different ways can we change the brightness of a bulb?" The students will offer their suggestions. The teacher should avoid making judgements and instead should accept and record the students' responses. Some students might limit their thinking and therefore, may not answer right away. In this case, the teacher should provide time in which the students can give their suggestions. Children tend to focus on one answer so rephrase the question, for example, "Is there only one way to make the bulb brighter?" Next, children's activities must be closely supervised. They must be fair, and variables must be controlled. Try to allow different groups of students to work on different activities.

An open ended lesson is advantageous because it encourages a variety of responses. However, students have to become accustomed to this mode of questioning, thinking and answering, otherwise, they will not understand that some questions have a variety of answers. All the varied responses need not to be investigated. The emphasis should be on the generation of possibilities as a means of expanding the students' awareness of their environment, as well as their ability to approach the question in different ways.

A Balancing Act
Presented at CESI Make, Take, Meet and Greet
by Cris Leibner, Kettle Moraine Public Schools, Wales, WI 53183, USA

Students encounter the action of the force of gravity without really thinking much about it. Besides holding things on earth, gravity allows coasting downhill on skis, bicycles, and skateboards. Playground slides, bouncing balls, amusement park rides, paper airplanes, swings and many other things are affected by gravity. Sometimes the force of gravity is used to balance things. Students of all ages can make and use a simple toy that can help them explore and learn about the force of gravity. "Corkies" can be made by using readily available materials. By making various adjustments to the position of the wires, "Corkies" can be made to perform gravity defying tricks.
Science and Technology in Action in Ghana

by Peter Towse & Jophus Anamuah-Mensah

Background

In spite of changes over the past quarter of a century or so, much of the science taught in Africa (and elsewhere for that matter) remains closely linked to narrow, out-dated examination syllabuses which continue to emphasise facts and the rote learning of concepts. Indeed, in schools throughout the continent one could be forgiven for feeling that any changes are largely illusory as one continues to see science taught by traditional 'chalk and talk' methods. Moreover, the countries of Africa have jumped onto the science and technology bandwagon without realising the part indigenous culture could play in ensuring the success of science education which, in effect, has always been installed in a cultural and historical vacuum.

Most secondary students thus view science as relevant only within the confines of the school laboratory (if there is one) and bearing no relationship to everyday life. Since few will study science further, such a narrow academic interpretation is wholly inappropriate. To hold well-informed and socially responsible views, one needs to have not only a knowledge of science and technology, but also an awareness of at least some of the issues involved in applying that knowledge to contemporary society. Thus, we should provide students with the opportunity to think about some of the issues and ask at least some of the right questions (Steward & Towse, 1987).

Writing in Ghana nearly twenty years ago, French (1973) emphasised the importance of studying science at secondary school, not only for the advancement of the community as a whole, but also for the future prospects of the individual. This is even truer today, and applies to all individuals. In other words, science is not solely the preserve of the future scientists. It follows that our courses in schools should not be geared solely to the pyramidal structures of old, where each stage of the educational system was seen largely as a preparation for the next.

The reform of science curricula in Africa has been discussed almost exclusively within the educational community, with little contribution from those in the wider 'world of work' which will absorb the school leavers. Perhaps science education is too important to be left only to those who practise it, and what we need now is a much wider involvement in deciding what science we should teach in our schools.

Science in Ghanaian Society (SGS)

In the early 80s efforts were made in different parts of the continent to bridge the gap between the science learned in school and that encountered in the 'real' world outside. One of these responses was the Science in Ghanaian Society Project, which attempted to see science and technology through Ghanaian culture. For, although science and technology principles, theories and laws are universal, the media in which they are found and the manner in which they are practised varies from culture to culture (Yakubu, 1984). In other words, there was a call for a view of science as practised within the local culture, or ethnoscience. Thus, modern technological methods may be used in the developed countries, but in the developing countries there is often a mixture of both traditional and modern methods.

Technology is not just about machines or processes. It is essentially about the application of ideas to solve human problems. Take, for example, the smelting of iron. Traditional methods of producing iron were used throughout Africa long before the advent of the blast furnace, yet only very rarely are such methods referred to in science lessons, even when they are currently practised. Haden (1973) drew attention to traditional iron smelting in Uganda, and his students worked with village elders to build a furnace. One of us tried to do the same in Zimbabwe, but was accused by some of trying to romanticise, even trivialise, these traditional practices. There is, of course, a danger of adopting an anthropological approach, but surely such practices are not so remote that this is inevitable. Indeed, such practices must surely be more relevant to large numbers of African students than the modern technological methods described in standard textbooks. That is not to say that we should not teach the modern methods, merely that the traditional methods are a more logical starting point. Indeed the two ought to co-exist, with different emphases on each at different levels.

SGS was not a course but a 'quarry of resource materials', a series of booklets produced by practising teachers for use in schools, training colleges, polytechnics, and adult education programs, in short to serve the needs of all those interested in endogenous development of Ghana. They were to do this by encouraging students to become aware of the rich scientific and learning potential of their environment. Relevant activity must start with the students and their experiences, and 'to humanise science is to make it relevant'. What a pity we cannot, at least occasionally, treat science as we would the arts. Then
students might see science not merely as a set of facts but also a collection of social, economic and political points of view. In that way we could truly expect to produce more informed citizens.

The SGS booklets covered traditional or cottage industries as shown in Table 1. The aims of this project were admirable, but the teachers' resource materials which were developed failed to reach many of the country's science classrooms. The emphasis in duplication was on minimum cost, and the materials lacked the photographs and other illustrations which would have made them visually more appealing. Also, they concentrated on the science involved and ignored many of the underlying issues, and there was no reference to the intermediate technology industries which offer employment to many school leavers. The SGS project has recently been revived but we are looking, with the support of the SGS team, to extend its philosophy by launching a new project called Science and Technology in Action in Ghana, which will produce materials for students as well as for teachers.

Science and Technology in Action in Ghana (STAG)

For far too long, the science taught in schools and the science practised in industry have been perceived as quite different. Moreover, through a lack of awareness of what goes on in industry, teachers have tended to oversimplify the application of scientific knowledge and concepts. We think the time is right to bridge the gap between school and industry, and bring industrial applications of science and technology more into the mainstream of science teaching, particularly at the secondary level. To facilitate this, we believe that those in universities, research institutions, and industry should pool their resources and help practising teachers by producing those materials to help in the day-to-day interpretation of science syllabuses.

Goldstein (1978) points out that in the USA secondary students use textbooks for up to 75% of the time they spend in class and up to 90% of the time they work at home. In Africa, where teaching methods are often very formal, the figures could be just as high - providing that there are textbooks available, of course. He finds it surprising that studies of the sociology of education in Africa pay no attention to the role of textbooks, which 'transmit socio-political values not just openly but also by omission, biased presentation of "facts" or indirectly when the values are hidden in an exercise or task to be done'. Aware, then, that it is not enough simply to produce support materials, but that such materials must represent a balanced view of the industrial activity of the country, we propose, as a first step, to produce a book which will reflect fairly and comprehensively what goes on in the following industries (see Table 2):

<table>
<thead>
<tr>
<th>Traditional or Cottage Industries covered by Science in Ghanaian Society booklets</th>
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<tbody>
<tr>
<td>palm wine</td>
</tr>
<tr>
<td>groundnut oil</td>
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<tr>
<td>palm kernel oil</td>
</tr>
<tr>
<td>shea butter</td>
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<tr>
<td>dragnet fishing</td>
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<td>fresh water fishing</td>
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<tr>
<td>fish preservation</td>
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<tr>
<td>sweet kenkey preparation *</td>
</tr>
<tr>
<td>Fanti kenkey preparation *</td>
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<tr>
<td>Ga kenkey preparation *</td>
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</tbody>
</table>

* Sweet kenkey or Ashanti kenkey is a sweet meal porridge. Fanti kenkey is fermented maize dough wrapped in plantain leaves and boiled. Ga kenkey is boiled corn dough balls wrapped in leaves.

<table>
<thead>
<tr>
<th>Ghanian Industries to be included in STAG Project</th>
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<tbody>
<tr>
<td>alcoholic drinks</td>
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<tr>
<td>aluminium</td>
</tr>
<tr>
<td>beer</td>
</tr>
<tr>
<td>biotechnology</td>
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<tr>
<td>boat building</td>
</tr>
<tr>
<td>cement</td>
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<tr>
<td>ceramics</td>
</tr>
<tr>
<td>cocoa and chocolate</td>
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<tr>
<td>electricity generation</td>
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<td>food processing</td>
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<tr>
<td>furniture</td>
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<tr>
<td>glass</td>
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<tr>
<td>gold</td>
</tr>
<tr>
<td>medicinal plants</td>
</tr>
<tr>
<td>mining (other than aluminium and gold)</td>
</tr>
<tr>
<td>non-alcoholic drinks</td>
</tr>
<tr>
<td>paints</td>
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<tr>
<td>petroleum refining</td>
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<tr>
<td>plastics</td>
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<tr>
<td>rubber</td>
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<tr>
<td>salt</td>
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<tr>
<td>soaps and detergents</td>
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<td>steel</td>
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<tr>
<td>textiles</td>
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<tr>
<td>timber</td>
</tr>
<tr>
<td>tobacco</td>
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<td>vegetable oil</td>
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</tbody>
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Table 1 Traditional or cottage industries covered by SGS booklets

Table 2 Ghanian Industries included in STAG Project
This will give a good cross section of the industrial activity of Ghana, for not only are these the industries which form the economic backbone of the country, they also provide employment opportunities for a large percentage of the country’s school leavers.

These accounts will be written initially by those working in the various industries. Our task will be to work with the teachers to eliminate bias, help with editorial changes, and assist in writing the final versions of the different accounts. Those in the field obviously have the technical knowledge; the teachers are familiar with the scientific and technological abilities and interests of children. Working together we are confident we can make that technical knowledge come alive for the students.

We are looking for fairly simple, straightforward accounts, written in a language and style that will appeal to secondary teachers and students alike. We hope that the accounts will be well illustrated with photographs, clear line drawings and, where appropriate, flow diagrams. A table will relate the various parts of the book to the syllabus, so that the full relevance of the material will be clear at all times.

Later, we will develop other materials for students, deriving in part from some of those materials produced above. Sometimes they will contain practical activities (for example, simulations of industrial processes), and sometimes they will provide the opportunity for examining certain issues in depth. In other words, they will have much in common with the Science and Technology in Society (SATIS) materials. We are also keen to produce cuttings booklets, case studies, games and simulations. Material will also be produced which describes examples of intermediate, even low, technology in the country, particularly those developed under the aegis of the Technology Consultancy Centre (TCC) at Kumasi.

Students in developed countries generally are aware of the laws and principles at the heart of scientific and technological activity in their own culture, but not of such activity in the Third World. This was the motivation behind the development of the Third World Science materials (Williams, 1983), intended to show students in the UK the science inherent in various activities in developing countries, for example:

- carrying loads on heads
- charcoal
- clay pots
- dental care
- distillation
- energy converters
- fermentation
- housing
- iron smelting
- methane digesters
- natural dyes
- plants and medicines
- salt
- soap

Why not, then, develop similar materials for use in the Third World itself, where students would be able to identify with the activities from personal experience? For some years, the Advanced Diploma course for overseas students at the University of Leeds has included the development of teaching materials based on various aspects of housing, sanitation, heating and cooking, blacksmithing and foundry work, and alternative energy sources (especially solar energy). This involves a lot of good, solid science which can be tackled through simple, everyday activities.

To appreciate the significance of the TCC as a source of relevant materials, one has to understand a little of its role in Ghana. Following the overthrow of Nkrumah and the collapse of his industrialisation program, the University of Science and Technology, Kumasi, founded to train the high-level manpower for that program, was forced to re-examine its role and adapt to the new situation (Powell, 1987).

It associated itself with Suame Magazine, the largest informal industrial area in Ghana comprising 27000 craftsmen, wayside auto-fitters and apprentices in 2000 shanty-style workshops. To many, the Magazine was a scene of squalor and disarray, but to the more astute it represented a considerable potential of human skill, ingenuity, enterprise and the will to succeed in a difficult and hostile environment. The University formalised its interest in grass roots development by creating the TCC, dedicated to solving technical problems brought to it by all Ghanaians, regardless of ability to pay. Some years up to 20% of its effort has been on behalf of Government or large businesses, which pay conventional consultancy fees, but its major effort has always been reserved for small-scale, informal, craft industry and agricultural projects funded either from inside or outside the country.

A number of enterprises were established, producing a wide range of products including steel bolts and nuts, gear wheels, agricultural tools, carpenters' saw benches and wood turning lathes, soap making plant, palm oil mill plant, food processing machines and charcoal kilns. Beekeeping and minimum tillage farming have been introduced and a pilot tilapia fish farm developed. Some 30 small-scale soap plants have been established, together with a similar number of rural palm oil mills.

The success of the pilot soap plant prompted the use of castor oil as a cheap alternative to palm oil, and led to the export of the technology to neighbouring countries. In Mali, where no palm oil is produced anyway, shea butter blended with fish oil or groundnut oil proved a surprising alternative!

The University has thus shaken off the traditional 'ivory tower image' and adapted to the needs of its environment. The success in Suame led to the establishment of two more units, one at Tamale and the other at Tema, and so the TCC has demonstrated its capacity to play a very important role in the economic development of Ghana. We consider this activity worthy of coverage in materials which reflect the full relevance of science and technology in Ghana.

The development of all these materials will actively involve teachers, several of whom will spend some time in the relevant industries or other activities to assess what would be most appropriate in the classroom and how best it might be achieved. The emphasis will be on an 'applications first' approach, as in the Salters schemes.
We will seek financial backing for the project from industry, educational trusts, aid agencies, etc., both inside and outside Ghana. Thus, although the materials will be produced to professionally high standards, the emphasis will be on keeping the cost to a minimum and putting the materials within the reach of every school in the country.

Initially, this will be a joint project involving the Universities of Leeds and Cape Coast but gradually, over a period of about two years, the University of Cape Coast will become solely responsible for the project.

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About the Authors

Peter Towse is a Lecturer in Science Education in the Centre for Studies in Science and Mathematics Education, University of Leeds, UK and has worked in curriculum development projects in Kenya, Lesotho and Zimbabwe.

Jophus Anamuah-Mensah is a Senior Lecturer in Science Education in the Department of Science Education, University of Cape Coast, Ghana. He was a Commonwealth Fellow at the University of Leeds, 1989-90 and a member of the team which developed the Science in Ghanaian Society materials.

For further details about the project, write to:

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University of Leeds
Leeds LS2 9JT, UK

Pasteur and Microbes
A Teacher Resource Book
Commemorating the 100th Year of the Pasteur Institute 1888-1988

This valuable resource book (166 pages) provides information about the activities and facilities available at the Pasteur Institute.

It also contains a variety of science experiments relating to the action of soil microbes, yeast as a food-making microbe, micro-organisms in milk, making cheese, making vinegar, and making wine, to name just a few. These activities are appropriate for secondary science teaching. Emphasis is on useful micro-organisms, food production and food preservation.

Order by sending US$8.00 or £5.00 (add 25% postage and packing) to:

Dennis Chisman
Hon Treasurer ICASE
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Proceedings of the International Seminar
6-8 June 1990
University of Dortmund, Germany

The proceedings (221 pages) includes the following papers: Using an expert system to analyse students' ability to process information in the area of basic electricity, Christoph von Rhoneck; Commonsense understandings of causes of motion, Denise Whitelock; Assessment of performance unit: a longitudinal study of science performance at ages 12 and 14 in the UK, Martin Braund; A label as hidden persuader: chemists' neutralisation concept, Hans-Juergen Schmidt; Student's understanding of the particle nature of matter and its relation to problem solving, Dorothy L. Gabel; Towards a more effective methodology of research on teaching and learning of mathematics: a critique, Elisabeth Sander; Introduction to the study of interdependence between selected traits and the use of the question-answer technique in problem solving, Matthias Ehrsam; On the methodology of the investigation of the pupils' structures of knowledge, acquired in the lessons of chemistry, Rolf Lammel; Concept learning in biology teaching, Diitmar Graf; Two decades of research in science education: an American perspective, Anne C. Howe; and other articles.

Copies, at a cost of US$8.75 including postage, can be ordered from:
Dennis Chisman, Honorary Treasurer, ICASE
Knapp Hill, South Harting, Petersfield GU31 5LR, UK

Science Teacher Education

A new ASE publication
The Association for Science Education (ASE) has recently launched a new publication called Science Teacher Education.

This is for all concerned with the pre-service education, induction and professional development of science teachers.

It is not a research journal but a forum for discussion. Issues will be sent out in January, April and September.

Sample copies are available from:
The Association for Science Education
College Lane
Hafter
Herts AL10 9AA
UK

The National Society for Clean Air: Teaching Pack
The National Society for Clean Air (NSCA) has published a teaching pack on the issue of global warming, or the greenhouse effect. The pack contains information, evidence and enquiry sheets which form the basis for a class exercise for fourteen to sixteen year olds.

Students are encouraged to sift through a range of material and to come to their own conclusions about what should be done about the problem. The pack also contains role play activity and teachers' notes. Copies are available at a cost of £3.00 from:
NSCA
136 North Street
Brighton BN1 1RG, UK
ICASE is keen to arrange regional or world events for the benefit of member associations. If your association or organisation is interested in hosting an international seminar, workshop or conference, contact the Executive Secretary or your Regional Representative. To gain ICASE endorsement, the meeting must be international in nature, open to member associations, and, while all sectors of the science education community should be encouraged to participate, must be relevant to classroom teachers.

1991

July 7-12
CONASTA 40
Location: The University of Adelaide, Adelaide, Australia
Contact: Tony Diercks, Convener, CONASTA 40, PO Box 346, Parkholme, SA 5043, Australia
The Australian Science Teachers Association invites you to participate in the fortieth annual conference of the Association. Prominent national and international educators, scientists and classroom practitioners will present keynote addresses and workshops on the theme "Merging the Boundaries". On the Tuesday of the Conference, the keynote lecture and workshops will be combined with the Australian Reading Teachers Association Conference at the Convention Centre. A variety of excursions are included in the program.

July 12-14
Annual Conference of ASERA
Location: Iluka Inn, Surfers Paradise, Gold Coast, Australia
Contact: Dr Cam McRobbie, Queensland University of Technology - Kelvin Grove Campus, Locked Bag No 2, Red Hill, Qld 4059, Australia
All those interested in science education research are invited to attend the 22nd Annual Conference of the Australasian Science Education Research Association.

July 14-19
GASAT 6 International Conference
Location: University of Melbourne, Victoria, Australia
Contact: Ms Gaell Hildebrand, School of Education, University of Melbourne, Parkville, Victoria 3052, Australia
The conference theme is Action for Equity: The Second Decade. During the past decade, the GASAT Community has explored the nature of the interaction between gender and science and technology, and debated a variety of explanations and solutions. GASAT 6 will focus on reflections upon past GASAT work, current initiatives relating to intervention and research, and perspectives on the challenges of the future.

July 24 - August 7
33rd International Youth Science Fortnight
Location: London, UK
Contact: London International Youth Science Fortnight, PO Box 159, London SW10 9QX, UK
The Science Fortnight is the principal international youth meeting annually organised in Britain, and is the major international meeting of young scientists in the world.

Details of the 1991 program, open to students of the sciences born between 24 July 1969 and 24 July 1974, are available from the address above.

August 4-9
ChemEd 91 Conference
Location: Oshkosh, Wisconsin, USA
Contact: Bruce G Smith, Co-Director, Appleton High School-West, Appleton, Wisconsin 54914, USA or Paul Kelter, University of Wisconsin, Oshkosh, Wisconsin 54901, USA
ChemEd 91 is a major chemical education conference of interest to university, college, secondary and elementary educators from North America and beyond. Throughout the weeklong conference, activities are planned for all members of the family including excursions, field trips, sports activities and social events - a feature of ChemEd conferences.

August 19-24
32nd Annual Conference of STAN
Location: General Murtala Mohammed College, Jimeta, Yola, Gongola State, Nigeria
Contact: Mr Ben B Akpan, Administrative Secretary, STAN, Government College Campus, PMB 5075, Ibadan, Nigeria
The Science Teachers Association of Nigeria invites you to participate in their 32nd Annual Conference. The theme of Teaching Science Technology and Mathematics in the Mother Tongue will include subthemes on philosophical implications, curriculum implications, implications for the learner, and implications for the teacher. The Conference will feature workshops, exhibitions, poster sessions, lead and contributed paper presentations, panel discussions, symposium, public lecture, subject panel meetings quiz, and launching of new STAN publications.

August 25-30
11th International Conference on Chemical Education
Location: University of York, York, UK
Contact: Dr John F Gibson, ICCE 11, Royal Society of Chemistry, Burlington House, Piccadilly, London WIV 0BN, UK
This biennial conference on the theme Bringing Chemistry to Life is being organised by the IUPAC Committee on Teaching of Chemistry in conjunction with UNESCO and
the Association for Science Education. The conference will focus on (1) making chemistry accessible to all students (2) new curricula at primary, secondary and post-secondary levels (3) new teaching strategies at all levels (4) teaching and learning at a distance (5) new frontiers of chemistry and their impact on teaching, and (6) research in chemical education. The program will include plenary lectures, poster papers, symposia, workshops, exhibitions, times for participants to discuss aspects of chemical education of special interest, social events and local visits. Responses to the first circular have been received from over 70 countries. The second circular and registration form is now available from the above address.

August 27 - September 1
5th International Environmental Education Conference
Location: Cusco, Peru
Contact: MSc Eduardo Gil Mora, National University of Cusco, Zaguán del Cielo L-9, Cusco, Peru
The conference will focus on the relationship between the environment and development, and on the changes needed in today's behaviour for tomorrow's world. The program will enable participants to learn of developments, approaches and strategies in environmental education in different countries, and will cater for primary, secondary and tertiary educators; and for teacher trainers, curriculum developers, and policymakers.

September 14-16
Conference on Teaching About the Protection of the Environment
Location: Krakow, Poland
Contact: Alicja Wojtyna-Jodko, Chairperson, Organising Committee, Stowarzyszenie Nauczycieli Przyrodniczych i Technicznych (SNPiPT), Skrytka Poczciowa 62, 85791 Bydgoszcz 32, Poland
This general interdisciplinary conference of teachers will be the first annual meeting of natural science and technology teachers active in institutions of education at the elementary and secondary levels, together with people from academic institutions with a vested interest in scientific and technical education. During morning plenary lectures, researchers will present the directions of research in ecology, chemistry and physics relevant to the theme. In afternoon sessions, teachers will join small group discussions focusing on sharing examples and experiences. Participants are requested to submit a brief summary of their intended contribution to these discussions. The working languages for discussion will be English and Polish. The first general assembly of SNPiPT (Association of Science and Technology Teachers) will discuss the future of this new association and elect officers. A meeting with a delegate of the Ministry will provide an opportunity for discussing the need for improving the level of scientific and technical education in Poland in light of the experience of other countries.

The Congress will focus on the important role of chemistry in raising the health conditions and living standards for all people. The program of plenary lectures, invited papers and contributed papers will be conducted in English and will concern various topics including organic chemistry of natural products, analytical chemistry and instrumentation, environmental chemistry, agrochemistry, coordination chemistry and its applications in medicine and agriculture, polymer science, photochemistry, computers in chemistry, catalysis, and chemical education.

August 12-22
Sixth International Symposium of IOSTE
Location: Wyndham Palm Springs Hotel and Resort, Palm Springs, California, USA
Contact: Dr. Herbert K. Brunckhorst, Institute for Science Education, California State University, 5500 University Parkway, San Bernardino, California 92407-2397, USA
The theme of the 6th International Symposium on World Trends in Science and Technology Education is Science and Technology Education: Responsible Change for the 21st Century. Science and technology education will be related to responsible change with respect to the role of science educators, scientists, engineers, business/industry and government agencies in the global community. The symposium will provide a forum for dialogue to increase awareness of regional perspectives worldwide and develop closer cooperation in addressing mutual concerns. This dialogue will be held in the context of science education issues, environmental issues, technology issues and socio-cultural issues. The symposium will be presented in English.

August 26-29
Conference on the Role of Experiment in Physics Education
Location: Skofja Loka, Slovenia, Yugoslavia
Contact: Seta Oblak, Zavod Republike Slovenije za solstvo Poljanska cesta 28, YU - 61 000 Ljubljana, Slovenia, Yugoslavia
The Board of Education in the Republic of Slovenia and the Department of Physics in the University of Ljubljana are organising a Europhysics study conference in cooperation with the European Physical Society. The theme will be "The role of experiment in physics education", with an emphasis on the changes taking place in classrooms due to rapid technological development. The program consists of lectures, workshops and group discussions as well as presentations of experiments suitable for students from elementary school to university level.

August 26-30
Fourth Asian Chemical Congress
Location: Beijing, China
Contact: Prof. Dehe Zhang, Secretary General of 4ACC, Chinese Chemical Society, PO Box 2709, Beijing 100080
The 4th Asian Chemical Congress will be held under the sponsorship of the Federation of Asian Chemical Societies.

November 6-10
NABT Annual Convention
Location: Souther Hotel, Nashville, Tennessee, USA
Contact: Patricia J. McWethy, Executive Director, National Association of Biology Teachers, 11250 Roger Bacon Drive, #19, Reston, Virginia 22090, USA

37
The next annual convention of the National Association of Biology Teachers will focus on the theme Form and Function: How Should They Be Taught. Applications for program space are due on 15 March 1991.

1992

January 3-6
ASE Annual Meeting
Location: University of Sheffield, Sheffield, UK
Contact: Annual Meeting Secretary, ASE Headquarters, College Lane, Hatfield AL10 9AA, UK
Full details of this large international event will be circulated in *Education in Science*, a journal of the Association for Science Education.

March 26-29
NSTA National Convention
Location: Boston, MA, USA
International delegates are invited to participate in the International Round Table - one of the many features of this large convention. Each country is provided one or more tables in a large room where delegates can display and present information on science education in their country. Visitors move from table to table, talking with the various representatives. If you require an invitation to participate, write to John E Penick, Professor and Coordinator, Science Education Center, The University of Iowa, Iowa City, Iowa 52242, USA.

March 29 - April 10
Science Teacher Education
Location: London, UK
Contact: Courses Department, The British Council, 10 Spring Gardens, London SW1A 2BN, UK
This British Council International Seminar will be directed by John Head and John May of King’s College Centre for Educational Studies, University of London, and will focus on secondary level teacher education, although some aspects will be of interest to those involved in primary science teaching. There are vacancies for 30 international participants - practising teacher trainers, advisers, inspectors, organisers of professional development programs and policy maker.

April 22-29
Symposium on Technology Education
Location: University College of Education, Erfurt, Germany
Contact: Prof D Blandow, University College of Education, Nordhäuserstraße 63, 5064 Erfurt, Germany
This symposium will be the first pan-European meeting on technology education to be held in a unified Germany - at an institution in Erfurt renowned for initiatives and developments in technology education. The principal aim of the symposium, which is being organised in collaboration with a number of organisations including ICASE and INISTE, will be to discuss technological literacy and competence in technology education within a European dimension. The majority of participants will be from European countries, with a few key people from other regions of the world. The principal language of the symposium will be English.

May 11-15
Second International History Philosophy and Science Teaching Conference
Location: Queen's University, Kingston, Ontario, Canada
Contact: Prof Skip Hills, Faculty of Education, Queen’s University, Kingston, Ontario, Canada K7L 3N6
This conference follows the very successful First International Conference on History, Philosophy and Science Teaching held at Florida State University in November 1989. All conference papers will be published in advance of the conference. Accounts of the application of history and philosophy of science in the science classroom are welcome, as are research papers on the issue.

June 10-12
ICASE Research Seminar on Chemistry and Physics Education
Location: University of Dortmund, Germany
Contact: Prof Dr Hans-Jürgen Schmidt, University of Dortmund, Department of Chemistry, Otto-Hahn-Straße, 4600 Dortmund 50, Germany
This symposium on empirical research in chemistry and physics education will focus on the methodology of empirical research in this field. There will be approximately 12 presentations each followed by a discussion period. The language of the symposium will be English. Presenters will be asked to send their paper beforehand, ready for printing as Proceedings through ICASE. Proposals of about 3 pages should include title, background, method, results, discussion, implications for research and teaching, and references, and should be sent to the contact above no later than August 31, 1991. General papers will not be accepted. Although there will be no seminar fee, participants will need to cover their own expenses.

July 6-10
CONASTA 41
Location: Perth, Western Australia
Contact: Convener, CONASTA 41, Science Teachers Association of WA, PO Box 991, West Perth, WA 6005
Australia
The Australian Science Teachers Association invites you to participate in the forty-fifth annual conference of the Association.

July 13-16
ISY International Conference for Invited Educators in Space Science and Technology
Location: National Convention Centre, Canberra, Australia
Contact: Dr John R Nicholas, Convenor, ISY Conference, University of Canberra, PO Box 1, Belconnen, ACT 2616, Australia
Museum and science centre educators with an interest in aerospace will meet with practising teachers who have shown talent in teaching young people about the nature of science through space science and technology themes. The theme “Space Enough to Learn” will focus on (Day 1) exemplary programs in museums and schools; (Day 2) critical review of
exhibits as a form of knowledge and entertainment, and the
role of technology in portraying knowledge of space
exploration; (Day 3) moving displays, teachers and learning
into the community and the marketplace; and (Day 4) dreams
of futures in space science and education.

August 2-10
Eighth ICASE Asian Symposium
Location: Colombo, Sri Lanka
Contact: Mr Asoka Weerasinghe
Hon. Joint Secretary, SLASME, Institute of Computer
Technology, PO Box 1490, Colombo, Sri Lanka
Science educators are invited to attend the eighth ICASE
Asian Symposium and enjoy the natural beauty of the
country and the hospitality of the Sri Lankans. The
Symposium, organised jointly by ICASE and the Sri Lanka
Association for Science and Mathematics Education
(SLASME), will feature outstanding speakers from many
countries who will address the theme "Science Education for a
Changing World". The Symposium aims to identify some of
the changes affecting our daily lives and to discuss ways by
which science education can respond to these changes.
Subthemes include (1) technology, (2) appropriate
technology, (3) environment, and (4) scientific literacy.
Participants will be able to experience the world famous

January 3-7
International Conference on Science Education in
Developing Countries
Location: The Amos De-Shalit Israeli Science Teaching
Center, Israel
Contact: Mr A Shoval, Ministry of Education and Culture,
Lev-Ram Building, 2 Dvora Hanavia St, Jerusalem 91911,
Israel (conference arrangements) or Dr Avi Hofstein,
Department of Science Teaching, The Weizmann Institute of
Science, Rehovot 76100, Israel (academic correspondence)
This international conference on the theme "Science
Education in Developing Countries: From Theory to
Practice" will review past experiences and achievements in
science education and plan for the 21st century with a special
focus on developing countries. The conference will feature
plenary lectures, symposia, poster sessions, workshops,
exhibitions, informal discussions, social events and local
visits. Topics for symposia and plenary lectures will focus
on current research on learning and teaching and its
implications for (1) the learner, (2) the teacher, (3) the
classroom, and (4) the curriculum.

APOLLO 11
A Teacher Resource Book
An ICASE Publication

This new publication, the latest of
a series of Commemorative Issues
produced by ICASE, has been
compiled to commemorate
the 20th anniversary of
the Apollo 11 Moon Landing
1969-1989. The book,
compiled and edited by
Linda Crow and Donna
Hare, provides information
and activities for both
elementary and secondary
science students.

Send US$10 or £6 plus
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Cheques payable to "ICASE"
Extending and improving education in science for all children and youth by assisting member associations throughout the world

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10 Hawken Street
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ICASE - supporting science teachers around the world
Science Education International is the Quarterly Journal of the International Council of Associations for Science Education. ICASE was established in 1973 to extend and improve education in science for all children and youth by assisting member associations throughout the world.

This journal provides a means for associations, institutions, centres, foundations, companies and individuals concerned with science education, to share perspectives, concerns, ideas and information which will foster cooperative efforts to improve science education, and which will serve as a chronicle of the advancement of science education throughout the world.

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**Dates for Receipt of Contributions**

<table>
<thead>
<tr>
<th>Issue</th>
<th>Closing Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>March</td>
<td>1 February</td>
</tr>
<tr>
<td>June</td>
<td>1 May</td>
</tr>
<tr>
<td>September</td>
<td>1 August</td>
</tr>
<tr>
<td>December</td>
<td>1 November</td>
</tr>
</tbody>
</table>

ICASE News

Feature Articles

Stereotypes of science and scientists
C R Boylan & D M Hill

Issues in the learning of science in Botswana Secondary Schools
R Charakupa

Astronomy Education International J R Percy

Science Education Around the World

Research for Teaching and Learning

Middle schools and STS: An ideal match B S Spector

Science Teacher Education

Multicultural science education by practicing teachers
A Arora & E Kean

Primary Science

Helping primary school teachers help children in science
D Palacio

Science Technology Society

Resources

Calendar

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ICASE News

NSTA National Convention
Houston, Texas, USA
March 27-30, 1991

This report was compiled by Dr. Kenneth Russell Roy, ICASE North American Representative

The National Science Teachers Association (NSTA) National Convention was held in Houston, Texas on March 27-30, 1991. The Convention's theme was "The Teacher is the Key: Science Teacher Professionalism". Emphasis on multicultural access was also central to the Convention. The thrust of this confab was most timely, given the goals of ICASE focusing on multiculturalism and global education.

Several ICASE activities highlighted the Conference. The NSTA International Committee met and was chaired by ICASE Special Projects Officer, Professor John Penick. ICASE President, Bob Lepischak, and North American Representative, Dr Ken Roy, provided information and items of interest relative to the activities and plans of ICASE. Specifically noted were ICASE Service Awards, ICASE publications including *Who's Who in Science Education Around the World*, the ICASE Stepping into Science Project, Conference '93 to be held in Paris, ICASE initiatives being developed for International Space Year 1992 including the World Activity Day, and the ICASE Five Year Plan under development.

At the International/ICASE Luncheon, Sergey Krotov, physicist from Moscow in the USSR, addressed the luncheon guests on "Science Education in the Soviet Union". The luncheon was hosted by ICASE President, Bob Lepischak, with comments on ICASE activities by John Penick and Ken Roy.

The ICASE/CASE Breakfast guests heard presenter Peter J Spratt, Editor, BRIDGES from Toronto, Ontario, Canada, address the topic of Business, Industry and Government Liaison with Education.

Promotion and innovation of science education in Nepal. NESES aims to promote and propagate the teaching and learning of science from primary to higher education; to disseminate the importance of science education; to promote the exchange of innovative ideas among member institutions; to develop cooperation among those involved in science education; and to contribute to science education policies, planning, implementation and evaluation.

For further information, contact: Dr K M Shrestha, President NESES, Reader, Central Department of Science and Mathematics Education, T.U. Kirtipur, Nepal.

Institute for Education and Research, Lahore, Pakistan

The Department of Science Education of the Institute for Education and Research, University of Punjab has joined ICASE as an Institutional Member.

For further information, contact: Dr Hafiz Muhammed Iqbal, Department of Science Education, Institute for Education and Research, University of Punjab, Lahore 54590, Pakistan.

ICASE welcomes new members

As the programs of ICASE are becoming more and more well known, associations, institutions and companies are joining ICASE as members. In welcoming these new members, we acknowledge the fine contributions that these organisations are making to science education.

Nepal Science Educational Society

The Nepal Science Educational Society (NESES) became established in 1991 as a nonprofit organisation of science teacher educators, science teachers and those interested in the dissemination, promotion and innovation of science education in Nepal. NESES aims to promote and propagate the teaching and learning of science from primary to higher education; to disseminate the importance of science education; to promote the exchange of innovative ideas among member institutions; to develop cooperation among those involved in science education; and to contribute to science education policies, planning, implementation and evaluation.

For further information, contact: Dr K M Shrestha, President NESES, Reader, Central Department of Science and Mathematics Education, T.U. Kirtipur, Nepal.

Institute for Education and Research, Lahore, Pakistan

The Department of Science Education of the Institute for Education and Research, University of Punjab has joined ICASE as an Institutional Member.

For further information, contact: Dr Hafiz Muhammed Iqbal, Department of Science Education, Institute for Education and Research, University of Punjab, Lahore 54590, Pakistan.

Eighth ICASE Asian Symposium
Colombo, Sri Lanka
2-10 August 1992

Science Education for a changing world

Contact:
Mr Asoka Weerasinghe
Hon. Joint Secretary
SLASME
Institute of Computer Technology
PO Box 1490, Colombo
Sri Lanka

Organised jointly by ICASE and the SLASME
Stepping into Science
CESI Make and Take

by Sue Dale Tunnicliffe
ICASE Project Officer
18 Octavia, Bracknell
Berkshire RG12 7YZ
England, UK

This exciting venture will happen at the ASE Association for Science Education Annual Meeting at Sheffield, 3-6 January 1992. The Stepping into Science Team is putting on the first international workshop. Based on the successful CESI Make and Takes run at science conferences in the USA, there will be a number of low cost activities from around the world for people to look at and try out. Philip Harris First Sense computer based activities will also be there for you to try out.

Please contact Sue Dale Tunnicliffe at the address above if you would like to contribute to this event.

The Organisation of Research and Educational Planning, Iran

The Organisation of Research and Educational Planning, Ministry of Education, Tehran, Iran has joined ICASE as an Institutional Member. For further information, contact Mr Daneshfar, The Organisation of Research and Educational Planning, Imam Khomeini Ave, Tehran, Iran.

Section Académique de l'Union des Physiciens Académie de Reims

This new Associate Member of ICASE is the Reims branch of the French national body - Association des Professeurs de Physique et de Chimie. For further information, contact Mme Nicole Herman, Section Académique de l'Union des Physiciens Académie de Reims, Lycée Roosevelt, Rue Roosevelt, 51100 Reims, France.

Philipp Harris International

Philip Harris International joins ICASE as a Company Member, and has already provided support for the ICASE primary science initiative - the Stepping into Science Project - by assisting with the production of the project's new Newsletter.

For further information, contact:
William Eadon, Philip Harris International, Lynn Lane, Shenstone, Lichfield, Staffs. WS14 0EE, UK.

South China Normal University

South China Normal University in Guangzhou has joined ICASE as an Institutional Member. For further information, contact Gao Lingbiao, South China Normal University, Guangzhou 510631, P. R. China.

Vietnam Union of Science and Technology Associations

The Vietnam Union of Science and Technology Associations (VUSTA) is a new member of ICASE. VUSTA is a voluntary organisation of scientific and technological associations working in Vietnam and abroad. Its aims at to promote national scientific and technological potential by uniting scientists, engineers and academics in common non-governmental programs; to communicate scientific and technological knowledge to the general public; to promote the application of science and technology to production and life; to monitor and provide advice on scientific and technological developments; to encourage scientists to be active in peace and environmental protection issues; and to advance the living standards and working conditions of scientists and technologists. VUSTA has 28 branch associations of specialised sciences, 7 territorial associations, 8 centres and companies involved in applying S&T into production and life, and 1 training and seminar centre.

For further information, contact Prof Dr Ha Hoc Trac, President VUSTA, 53 Nguyen Du Str., Hanoi, Vietnam.

Association of Science and Technology Teachers, Poland

The Stowarzyszenie Nauczycieli Przedszkolnych i Technicznych (SNPPI), formed in September 1990, has joined ICASE as a Member. The Association brings together teachers and teacher educators at primary and secondary levels in all scientific and technical fields. Plans are underway to conduct symposia, refresher courses, and an annual general congress.

For further information, contact Alicja Wojtyna-Jodko, Chairperson SNPPI, Skrytka Poczta 62, 85791 Bydgoszcz 32, Poland.
Project 2000+
by Dr Jack Holbrook
ICASE Executive Secretary

In the March 1991 Issue of this Journal, it was reported that ICASE had commenced planning, in conjunction with Unesco, a major world conference to be held in Paris in 1993. At a planning meeting in June, it was decided that this Conference become part of a new initiative, entitled Project 2000+.

Project 2000+ calls for a rethink of science and technology education in the formal (school), non-formal (out-of-school), and informal (adult) education setting for the year 2000 and beyond.

This is based on the premise that science and technology education is needed by all, but that current science programs are too difficult, too factual and largely irrelevant, except for the few who wish to take up a scientific career. It is also based on the premise that science and technology education is important, but poorly understood, often unavailable and confused with technical or vocational training.

It is felt that there are sufficient small scale science/technology projects around the world to illustrate that there are alternative approaches which promise to provide more literate programs for students as a whole. Just as Education for All was a theme of a worldwide commitment in 1990 (Jomtien, Thailand conference outcome, 1990), so Scientific and Technological Literacy for All is the theme of this follow-up project. As such it is seen as both a developed and developing world concern.

ICASE contends that new developments will only be successful if a partnership is established between governments and science/technology teachers. STAs (Science Teacher Associations) or Centres/Institutions thus have an essential role for the successful implementation of any new direction, particularly if this involves teachers adopting a change of outlook. ICASE thus recognises that its member organisations are important to Project 2000+. Their willingness to be involved, especially in Phase 3, is crucial.

Project 2000+ is a large undertaking and will need substantial funding. Other partners are being sought, especially those co-sponsoring the Education for All Project, to help with financing much of Phase 1 and 2, and for continuing support of Phase 3.

At this stage, the project is given in outline - a fuller account will be made available to those member organisations expressing an interest in becoming involved in Project 2000+.

Project 2000+ has been divided into three phases:

Phase 1 is a data gathering stage (1991-3), to collect research papers, journal articles and especially exemplary program materials related to the theme. A database will be reated, and links made with other conferences to feed outcomes and ideas for consideration in this project.

Phase 2 will be a worldwide conference, held in July 1993, to discuss the issues and dilemmas and to provide outcomes that give clear directions for the future. This may be in the form of resolutions or working models for implementation.

Phase 3 is the developmental stage and represents a longitudinal, within country program to modify existing practices where these are found wanting. Developments could be under the guidance of Unesco/ICASE although local participation would be the major thrust. The project would be extensive and provide training and evaluative studies as well as support for the local organisation to enhance teacher morale, teacher support and teaching conditions.

Note: Member organisations of ICASE have been sent a Reply Slip in order to indicate their willingness to be involved in Project 2000+.

For further information about Project 2000+, contact:
Dr Jack Holbrook
ICASE Executive Secretary
Department of Curriculum Studies
University of Hong Kong
Hong Kong

Review of the Literature on Scientific and Technological Literacy

In preparation for the major Unesco-ICASE Conference to be held in Paris during 1993 as part of Project 2000+, ICASE is completing a review of the literature on scientific and technological literacy.

Please send any articles or abstracts on these subjects to:
John E Penick
Science Education Center
789 VAN
University of Iowa
Iowa City, Iowa 52242
USA

All submissions will be acknowledged in the review.

Coming ICASE Events

For further details about these ICASE endorsed events, consult the Calendar in this issue.

April 26 - May 1, 1992
INCOTE 92 International Conference on Technology Education, Weimar, Germany
Contact: Dawn Robertson, Janet Jones Associates Ltd, Westfield College, Queens Building, Kidderport Avenue, London NW3 7ST, UK

June 10-12, 1992
ICASE Research Seminar on Chemistry and Physics Education, University of Dortmund, Germany
Contact: Prof Dr Hans-Jürgen Schmidt, University of Dortmund, Department of Chemistry, Otto-Hahn-Straße, 4600 Dortmund 50, Germany

August 2-10, 1992
Eighth ICASE Asian Symposium, Colombo, Sri Lanka
Contact: Mt Asoka Weerasinghe
Hon. Joint Secretary, SLASME, Institute of Computer Technology, PO Box 1490, Colombo, Sri Lanka
Stereotypes of Science and Scientists

by C R Boylan and D M Hill
Charles Sturt University - Riverina
Wagga Wagga, Australia

Considerable interest in the way in which science is portrayed in the media, school texts and student artifacts has occurred in the last decade. The process occurring in science classrooms, the proportions of males and females enrolled in science related educational programs and the proportions engaged in different forms of science-related employment have received much attention. The prime purpose of such research was to establish the social context in which girls grow up and make decisions relating to science studies and future employment. According to Kelly (1987) and other authors whose papers she collected in Science for Girls, girls tend to see science in the following terms: competitive, impersonal, convergent, abstract, restrictive, male, unimaginative, mechanistic, certain and rule-bound. Whyte (1986) has made similar claims: girls are seen as warm, literate and interested in people whilst scientists are portrayed as competitive, rational beings interested in things.

Mason, Kahle and Gardner (1991) claimed that female students participated in fewer science activities than males and that they were less likely to engage in activities, at home, which develop the kind of competencies needed in science classes. Male students are more likely to have experience with mechanical toys, construction kits, chemistry sets, and field trips than females (Jones and Wheatley, 1988). Teachers of science have been found to treat male and female students differently in class (Mason and Kahle, 1989).

The outcomes from these research studies have promoted attempts to change school science programs to achieve greater gender equity. Such changes include the establishment of single sex classes, an examination of the topic of stereotypes and creating classroom environments which are gender neutral. The developers of these programs have assumed that the information we have about the image of science and scientists held by students is valid. The purpose of this article is to examine this assumption.

Information about students' ideas about science and scientists has been gained by researchers who have usually adopted a sociological or psychological framework. Sociologists have emphasised the importance of social context in the development of such images. Their primary interest is in social and material conditions rather than in the role of individuals in social processes. Hurrelmann (1989) has claimed that sociologists have either ignored the latter or assumed the role to be a relatively passive one. Many cognitive psychologists, however have taken a contrary view: individuals are seen as active agents concerned with constructing and managing their own inner and outer reality. In this paper it is argued that such realities can be best understood in terms of a broad ecological framework (Bronfenbrenner, 1979) which embraces both psychological and sociological perspectives.

One of the main ways in which researchers concerned with social context have investigated students' views of science and scientists has been through a study of students' drawings using the Draw-A-Scientist Test (DAST) developed by Chambers (1983). The test procedure involves inviting students to draw-a-scientist and subsequently analysing their drawings for the presence of various indicators described by Chambers (1983). Hassard (1990) has summarized the stereotypes which have been identified in studies employing this technique as follows:

- The scientist is usually a male Caucasian.
- The scientist is either bald or has frizzy, wild hair. On the rare occasions when the scientist is a woman, her hair is in a bun.
- The scientist wears glasses and is dressed in a white lab coat.
- The scientist is shown working alone in a laboratory rather than in nature or in the field.
- The scientist is shown mixing chemicals or doing some kind of chemistry-related or physics-related experiment.
- The scientist is shown experimenting with dangerous things and is sometimes shown experimenting on people. (Hassard 1990: 10)

Kahle (1989) claimed that not only did students hold a masculine view of scientist but also of science and 'that this image probably detracts from a girl's interest and self-confidence in doing science' (Kahle, 1989: 5). She argued that DAST is both valid and reliable. O'Maoldomnaigh and Hunt (1988) have claimed that many studies have shown that different people agree in their coding of the same student drawings. Schibeci and Sorensen (1983) claimed that interviews with students can provide evidence for the validity of DAST. It appears that such interviews were often conducted after the student had completed a drawing of a scientist. This raises the possibility that the two measures are confounded.

The DAST can be described as 'epistemologically flat' (Kilbourn, 1982) in so far as there is insufficient context developed for the task for the respondent to know how to reason. Symington and Spurling (1990) have questioned
whether the prime purpose of the task is to assess an individual's knowledge of the public stereotype of the individual's private views and knowledge about science and scientists. Hill and Wheeler (1991) claimed that DAST explored the public rather than the private or inner knowledge of subjects and that a different kind of procedure was required to assess the latter.

Boylan, Wallace and Sharman (1990) and McNay (1988) have questioned the validity of the DAST procedure because these authors contend it tapped only part of a subject's understanding. These researchers found that subjects knew a lot more about science and scientists than their drawings revealed. The students recognised the limitations of their drawings as a once only portrayal and they could clearly distinguish between what is and what could be. McNay (1988) argued that if science teachers were asked to 'draw-a-scientist' they too would respond superficially and produce a stereotypical image. It has been observed that the very way in which the directions for the Draw-A-Scientist Test are given indicates that there is such a thing as a typical scientist and this is what the subject has to represent. When responding to the DAST, subjects are forced to make a series of choices concerning such things as: gender; age; race; dress of the person; the setting; and task to be portrayed. It is hardly surprising that such drawings revert to the public perception of science and scientists.

O'Maoldomhnaigh and Ni Mhaolain (1990) altered slightly the directions to the DAST to 'Draw a man or woman scientist' and obtained a very different response from students. They attributed this result to the changed expectations of the subjects created by the new directions. They found the new directions significantly increased the proportion of women scientists represented in the drawings made by young adolescents.

As students progress through school they develop images of particular occupations. These images usually involve similarities and differences on a number of dimensions including gender (masculinity/femininity), prestige, work conditions and types of work tasks performed according to Gottfredson (1981). Occupational images become more realistic by the time students reach upper secondary school. This kind of knowledge is constructed gradually as students grow in capacity to comprehend and organise information from multiple sources. Gottfredson (1981) has also argued that, as a result of this process, students develop a set of occupational preferences and perceptions of accessibility which, in turn, define their career aspirations.

It has usually been assumed that students' preferences are consistent with the stereotypes which are public knowledge in their society. The findings of a number of studies by O'Maoldomhnaigh and Hunt (1988), Fort and Varney (1989), Kahle (1989), and Mason, Kahle and Gardner (1991) appear to confirm this. However, as Boylan, Wallace and Sharman (1990) have demonstrated, this evidence must be seriously questioned. Using the Osborne and Gilbert (1979) Interview-About-Instances procedure, these authors have attempted to tap into both the sociological and psychological frameworks held by students. They used a series of pairs of illustrations which were also used by Yakop, Hill and Wheeler (1989) to focus on four aspects of the image of science and scientists held by Grade 7-10 high school students. These were:

- Appearance, eg clothing and age;
- Task, eg reading instruments and recording data;
- Work setting, eg laboratory and outdoors; and
- Employment/gender, eg male and female doctor or male and female pharmacist.

Some examples of the illustrations used by Boylan, Wallace and Sharman (1990) are reproduced here.
Each student was individually interviewed and asked such questions as: 'Is one of these two persons more likely to be a scientist than the other?' 'Could they both be scientists?' 'Could neither be a scientist?' Students were asked for reasons for their responses to these questions and their reasons were probed to elicit further detail.

Boylan, Wallace and Sharman (1990) reported that Grade 7 to 10 Australian students were able to provide stereotypical views about science and scientists. However, when an analysis of the reasons given to support the students' statements was conducted, they found a complexity and diversity of reasons that revealed insights into student perceptions that went beyond the stereotype. They reported that the students held a sophisticated view about science and scientists in which both the public stereotype and the students' private perception co-existed. The students were able to separate what is the current image of science and scientists (e.g. more males employed as scientists) from what could be possible for the student and to distinguish between gender stereotyped science careers and potential science careers for the student in which gender was not perceived to be a barrier. Similar levels of sophistication in student understandings and perceptions of science and scientists have been reported by Wheeler and Changeywo (1990) with Canadian students in Grade 7.

If the very evidence on which school science programs have been devised to 'correct' students' views of science and to encourage more girls to take up scientific careers is based on the public and superficial image, then it follows that the resources used to implement such programs represent inappropriate strategies and wasted effort. Further, if the assumptions are false and students already hold realistic and discriminating understandings about science and scientists, then the effectiveness of such programs which claim to produce change in students' perceptions of science and scientists need to be carefully re-evaluated.

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Issues in the Learning of Science in Botswana Secondary Schools

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Introduction
As a developing country, Botswana is striving for both improved technological and social well-being for its citizenry. A step toward achieving this goal was taken decades ago when science and mathematics curricula were introduced in Botswana schools. Clearly, the expectation was that a majority of the local students would be able to learn these subjects and, in time, this would lead to an increase in techno-scientific awareness among the population. This goal has not as yet been fully realised. The learning of science and mathematics has been, and still is fraught with many problems, some of them intractable. These problems may be categorized as follows:

- Learner background factors
- Science teacher background factors
- Science teacher preparation
- Science content delivery hurdles

Discussion of each of the above categories follows with a view to identifying problems, weaknesses and constraints.

Problem Areas

1. Learner Background Factors
The majority of Batswana pupils come from a rural, basically non-technoscientific (in the western sense) background. While they may be exposed to forms of indigenous science and mathematical concepts at an early age, such concepts are inadequate as prerequisites for the meaningful learning of the more formalised versions taught in secondary schools. A compounding factor is that a good number of these pupil's parents are functionally illiterate or semi-literate with an even larger number being scientifically illiterate. Clearly this leads to minimum after-school and in-the-home support for science and mathematics learning activities.

Germain to this latter point is the absence of an environment, both physical and cultural, which is conducive to a rich science experience and one which can augment in-school science learning. This may very well mean that for the majority of the pupils, science is only 'experienced' during the hours allocated to it on the school timetable. The import of all this then, is that the pupils may not be harnessing all their potential and other innate abilities in the process of learning science. An immediate consequence of this is a limited output of science and mathematics graduates who may in the future further the causes of localisation in the various scientific and technological fields, a goal highly cherished by the Botswana nation.

2. Science Teacher Background Factors
A typical science learning situation in the Botswana classroom context often entails teacher-pupil dialogue or interaction. At times, usually not with optimum frequency, the learning situation may assume a laboratory setting. It is easy to see that in these learning situations there is often a 'hidden' interaction between pupil background and teacher background factors. The teacher background factors that are of interest in the present discussion are the following: socio-cultural, educational, attitudinal and professional experience. The Botswana science and mathematics teaching force is made up of both Batswana and expatriate personnel. It is therefore immediately evident that there exists a diversity of socio-cultural, educational and professional backgrounds among the science and mathematics teaching force in Botswana schools. Even considering the Batswana teachers alone, the aforementioned diversity exists, albeit to a limited extent.

Let us focus initially on the background factors as they relate to the expatriate teaching force. This component of the teaching force, which presently outnumber the local component is sourced from different countries, notable examples being the United Kingdom, the United States, India and the various African countries. There is ample reason to believe teacher preparation programs are, to a real extent, unique to the learning environments existing in each of these countries. Thus, teachers are trained bearing in mind a more or less specific environment in which they will later function. It is unlikely, for example, that teachers trained in India or the United States are prepared with Batswana pupils in mind. While this latter point may be of little significance at the tertiary level of education, it is crucial in the context of secondary and lower levels. Knowledge or expertise of how to teach science to an American pupil does not readily translate into knowledge or expertise of how to teach science to a Motswana child due to the complexity of the factors that impinge on the teaching-learning process. Clearly, this has serious implications for the learning of science in Botswana schools.

First, the newly appointed expatriate teacher usually has no real feel for the background or initial state of his pupils, except perhaps for the prejudices he may have unwittingly acquired from those 'who have been there'. In terms of exposure to science and technology, the Batswana pupil from rural areas (the majority come from rural areas) may very well have a 'deficit' at the start of his secondary schooling. Confronted with a situation where the pressure is intense to 'get on with the syllabus', the expatriate teacher will limp along as best as he or she can under the circumstances. Teacher-pupil communication may thus be rendered partially ineffective, resulting in learning of dubious quality or efficiency. If the expatriate teacher has a low threshold of
frustration, he may be tempted to conclude that the scientific or mathematical concepts he is trying to impart to the pupils are beyond them. This is especially easy for the expatriate teacher to believe if he or she has been subjected to similar views from ‘experienced’ expatriates. Under these conditions not enough effort is expended in examining conflicts between teacher and pupil backgrounds. Science and mathematics learning therefore will proceed under suboptimal conditions.

Second, a Motswana pupil is, more often than not, taught by more than one expatriate teacher during his secondary education due to the turnover of contract staff. Chances are that the pupil is exposed to science teaching from teachers with different backgrounds, attitudes and professional experience. The process of adjusting to changes of teacher may lead to learning difficulties, the intractability of which increases with nearness to final examinations. Closely allied to this problem, is changing ‘types of English’, the medium of instruction. To the student, an American speaks different English from a Briton, an Indian, or a Ghanaian. Adaptation to this new change occurs in real time, during which period science and mathematics learning may be hampered, particularly for the weak or average pupils.

Last, concerning expatriate teacher background, there are indeed some expatriate teachers in the country who have overcome conflicts in pupil-teacher background and are obtaining very good pupil performance in science and mathematics examinations. The background of local teachers will be discussed under teacher preparation.

3. Preparation and Supply of Science Teachers

This category will primarily focus on the training of Botswana teachers. The accelerated expansion of secondary education has resulted in a large demand for teachers, particularly science and mathematics teachers. Until a few years ago, in-country preparation of secondary science teachers was carried out mainly at the University of Botswana. In order to compete with new demand for teachers, particularly at the junior secondary level, two new institutions have been recently established: the Molepolole and Kgalagadi Colleges of Education.

A vexing problem in the area of teacher preparation concerns the type of candidate attracted to the profession. It is common knowledge that a good science student would not consider teaching as a first career option. The reasons for this are numerous. The teaching profession is perceived to have little prestige except perhaps in the rural areas where the teacher may be an intellectual beacon on a generally unschooled flatland. Thus mostly average to slightly below average science students will go into science teaching. If educational programs are to justify their existence, a majority of these average candidates must emerge from university or college with a qualification of some sort. These teachers of average quality then go into secondary schools to teach science to students with deficits in science experiences. The situation then is one where teachers are expected to teach the same material that they found difficult in their own early schooling. The present arrangement between the Ministry of Education and the University of Botswana where one third of secondary science graduates are channelled into science and technologically-oriented careers ensures that relatively less able candidates go into the education programmes. By some deviousness there have been years when even more than one third of good science graduates have been lured away by the faculty of science. Several factors are therefore at work to ensure good science students do not easily end up in the teaching profession. Similar observations were made by the National Commission on Education (1977). Commenting on the quality of entrants to the teaching profession, the Commission observed:

"Here one is confronted with a vicious circle, because so long as the quality of the teaching profession is low, good new recruits will not be attracted to it. Yet the standing of the profession can only be raised by recruiting better candidates and providing them with better training."

Attempts have been made to turn weak candidates into good teachers. Kahn (1983) observes that the Diploma in Secondary Education (DSE) offered at the University of Botswana takes weak candidates who would not normally be considered able to do advanced level work and educates them beyond A-Level standard. Kahn further states that these DSE graduates leave the university with a broader view of science than their degree counterparts and are highly regarded in schools. Assuming Kahn’s observation to be correct, the DSE output is numerically insufficient to staff the schools with good science teachers. All these factors impact negatively on the science teaching-learning process. Consequently, pupils are not always exposed to the best of teaching during their secondary schooling, resulting in possible inefficiency in the learning process.

4. Science Content Delivery Hurdles

According to Anderson (1976), the body of scientific knowledge has grown to massive proportions and few people are certain as to the appropriate content to be included in pre-college curricula. Anderson further observes that:

"It is more clear now than ever before that we must select carefully what kinds of information will be presented and with what kinds of orientation."

In the Botswana context science content should be selected on the basis of relevance to life in Botswana. This entails an intimate knowledge of a pupil’s background and the concepts of science and mathematics he brings to a learning situation. Armed with this knowledge, the teacher can then build on such concepts, thereby facilitating the learning process. Indeed, educational researchers in the learner pre-conception or misconceptions field have highlighted the desirability of incorporating the ideas pupils bring to a learning situation into teaching strategies. In Botswana, very little research has been done in this area. However, a study by Prophet and Rowell, is the imposition of teacher viewpoints on students leading to inhibition of development of connections between students’ existing ideas and those presented in class. The impact of this on learning is obvious; the learning process becomes less efficient. The reader is encouraged to consult the Prophet and Rowell study for an excellent ‘snapshot’ of classroom interaction.

Another hurdle that limits the efficiency of the learning process is that science laboratories are inadequately equipped. The problem is particularly chronic in junior secondary
schools. Here one finds groups of up to six students sharing equipment.

Observations during teaching practice reveal that under these conditions not all group members participate equally in the practical work, resulting in different degrees of learning. The use of highly structured worksheets in integrated science tends to discourage free-formal thinking on the part of the student. On the teacher's part, there may be a tendency to focus on the completion of the worksheets to the detriment of everything else. The lack of skilled technicians in these schools means that if equipment breaks down it may remain out of commission for a long time, thereby restricting the range of activities students carry out during practical sessions. Concepts that could be better illustrated using the practical method are therefore rendered that much more difficult for the student.

Possible Solutions

The prescription of solutions to complex educational problems is a hazardous task. This is compounded by the existence of divergent perceptions of what constitutes a solution. To the bureaucrat, it may be more important for large numbers of students to be exposed to a learning situation without due regard to the quality or efficiency of the learning process. More students mean more teachers, therefore, recruit more teachers from wherever they are available. Should there be a donor country willing to supply teachers, all the better. The bureaucrat blithely assumes that the donor will supply experienced teachers. To him, it is all largely a numbers game. To the professor of education the solution lies in his area of specialisation. If he is a psychologist, the difficulties pupils encounter in learning may be partly alleviated by application of an appropriate psychological model. If she is a 'methods' person the solution may lie in the use of an appropriate teaching method. To the educational philosopher, the answer may be found in the unambiguous specification of relevant educational philosophies.

A 'content' specialist will focus on selecting relevant content and matching it to the learning group in question. The educational technologist will advocate the use of various teaching aids and media, for example, computers, overhead projectors, etc. The solution field goes on and on. It should be possible to find common ground and improve the learning of science and mathematics in our schools, despite this divergence of possibilities.

The impact of learner background on learning may be reduced if beginning junior high school science students are taught by competent and experienced Batswana teachers whose background experiences are similar to those of the students. Such teachers may be better placed to put the students' problems into context and not be quick to dismiss students' 'wrong answers' as ridiculous. In this regard, the current practice of using less qualified diploma graduates to teach junior pupils need to be re-examined. This is important given that a student's early encounter with science may shape his future attitude toward the subject. If the early experiences are negative, the nation loses potential scientists, thereby slowing the pace of localisation in scientific and technical fields.

A good teacher is partly the product of good training. While justification exists for current drives to produce large numbers of science teachers, teacher trainers and others concerned should ensure that the teaching profession does not become the depository for the less able. Care should be taken to ensure that those successfully going through teacher preparation programs do so based on their ability and not because they are needed to boost the numbers in the profession. Once in the profession the teacher should be kept abreast of developments in his field through meaningful in-service sessions. Such sessions are more than get-together

New inert element: Administratium discovered

April 1: The heaviest element known to science was recently discovered by physicists at Turgid University. The element, appropriately named Administratium (Ad), has no protons or electrons, which means that its atomic number is 0. However, it does have 1 neutron, 125 assistants to the neutron, 75 vice-neutrons, and 111 assistants to the vice-neutrons. This gives it an atomic mass number of 312. The 312 particles are held together in the nucleus by a force that involves the continuous exchange of meson-like particles called memo-ons.

Since it has no electrons, Administratium is inert. However, it can be detected chemically because it seems to impede every reaction in which it is present.

According to Dr M Languor, one of the discoverers of the element, a very small amount of Administratium made one reaction that normally takes less than a second take over four days. Administratium has a half-life of approximately 3 years, at which time it does not actually decay. Instead, it undergoes a reorganisation in which assistants to the neutron, vice neutrons, and assistants to the vice-neutrons exchange places. Some studies have indicated that the atomic mass number actually increases after each reorganisation. Administratium was discovered by accident when Dr Languor angrily resigned from the chairmanship of the physics department and dumped all of his papers into the intake hatch of the university's particle accelerator. "Apparently, the interaction of all those reports and minutes with the particles in the accelerator created the new element" Dr Languor explained.

Research at other laboratories seems to indicate that Administratium might occur naturally in the atmosphere. According to one scientist, on college and university campuses, Administratium is most likely to be found near the best appointed and best maintained buildings and is closely associated with carpeted floors.
sessions. Proper assessment procedures should be devised to determine the usefulness of such workshops in relation to changes in the teacher’s classroom practices. This would be more useful than simply asking teachers whether they considered a given workshop useful. Workshops could also be used to help expatriate teachers acquire a correct perspective of the Botswana pupil’s background and culture in order to minimise expatriate teacher - local pupil background conflicts.

Within the constraints of donor strings, educational officials should press for an active role in selecting the kind of expatriate science teacher that is recruited. In this regard, and financial resources permitting, teacher recruiting expeditions should include representatives from institutions concerned with secondary science as well as ministry officials. Together these representatives will be better placed to advise the government and the donor on the suitability of prospective candidates.

Conclusion

This paper has discussed a few important factors that affect the teaching and learning of science in Botswana’s secondary schools. These are learner and teacher backgrounds, quality of teacher preparation programs, the equipping of junior secondary schools and the kind of candidate that enters the teaching profession. A desirable situation is where academically able students enter into well thought-out and good quality teacher preparation programs that enable them to teach competently, taking into account the belief system that students bring to their learning situation. Institutions concerned with teacher preparation should not hasten to yield to political pressure to focus on quantitative rather than qualitative production of science teachers. To maintain continuing teacher competency in their fields, meaningful workshops should be organised. Proper assessment of such workshops is desirable to ensure changes in classroom practice. Broadly-based recruiting teams are needed to assist in the selection of expatriate science teachers. The combined efforts of government officials, academics and the community are needed to ensure that a good atmosphere exists in the science classrooms of our schools. This will enhance the production of good science students and facilitate broader participation of our citizens in scientific and technical fields.

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An Invitation to Boston
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Each year, the International Committee of the National Science Teachers Association, USA hosts an “International Round Table”.

At this 90 minute session, presenters from different parts of the world discuss their nation’s educational programs. Each presenter has a table for materials, and participants select those countries they wish to learn about.

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Astronomy Education International

by John R Percy
Erindale Campus
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Astronomy is deeply rooted in the culture of almost every society, by virtue of its practical importance in time keeping and navigation, and its philosophical and religious implications. Today, the practical applications of astronomy are mostly forgotten, and it has become the ultimate 'pure' science. As the mathematician Henri Poincaré said:

"Astronomy is useful because it shows how small our bodies, how large our minds."

Astronomy plays a fundamental role in basic science; the universe is a laboratory in which we can observe processes which cannot be duplicated on earth. Astronomy captures the imagination of the public, and contributes to a sense of shared exploration and intellectual excitement. It therefore has the potential to raise the level of scientific literacy in a society, and to attract young people to a study of the sciences. It provides an enjoyable leisure time activity for millions of people. Astronomy is unique among the sciences in the extent to which 'amateurs' can contribute to education and research.

Astronomy has no set place in the school curriculum. This is partly because science curriculum is determined nationally or locally, and partly because astronomy is not considered a 'core' science, and is discarded by some educational jurisdictions as being irrelevant or unteachable. Basic astronomical facts and concepts are usually taught in elementary school. In the 'classical' European curriculum, it is often taught also in secondary school, as a rigorous science. In the 'populist' North American curriculum, it is often taught in university, as a descriptive survey course, to non-science students, to satisfy a requirement for a science course in their program. As a result, dozens of different astronomy textbooks are available for non-science students, but relatively few for science students.

Because of the varied role of astronomy in the curriculum, the possibilities for international co-operation in astronomy education are limited - but certainly not negligible.

The International Astronomical Union

The IAU is a non-governmental union whose goal is 'to promote astronomy . . . and develop it through international co-operation'. Over 50 countries adhere to and support the IAU, and most of the world's active professional astronomers (6711 at present) are members. Members are nominated by their country; there is no membership fee. The IAU holds a triennial General Assembly, Regional Meetings, Symposia and Colloquia (over 200 in total), all in different parts of the world. It has over 40 'interest groups' called commissions, one of them dealing with education.

IAU Commission 46 (The Teaching of Astronomy)

This commission consists of an 'organising committee' or executive, representatives from each of the countries adhering to the union, and members-at-large (including some from less-developed countries which are not yet part of the union). The commission is particularly concerned about the needs of the developing countries, and most of its programs and projects reflect this. In many developing countries, there are only one or two astronomers, who are responsible for all aspects of astronomy education - teaching university courses, training school teachers, writing books and articles for amateurs and the public, and acting as resource people for government, schools, media and the public.

International Schools for Young Astronomers

Every year or two, the IAU and UNESCO hold an intensive two week school for young astronomers (scientists, graduate students, teachers) in a developing area of the world. The most recent have been in Cuba, Malaysia, and Morocco. A core of experienced instructors works with 20 to 30 participants, giving lectures, organising seminars and discussion, and suggesting projects for future research. Communication between instructors and participants often continues for many years after!

The Vatican Observatory also holds international summer schools every two years, at the Pope's summer residence at Gandolfo. The school lasts for five weeks, bringing together about two dozen graduate students, mostly from the Third World. The Vatican provides free room and board, and up to 75% of travel expenses.

Visiting Lecturers Program

This is a more leisurely program in which a series of lecturers visit a targeted country for weeks to months, giving courses, supervising student projects, consulting with local astronomers, and generally working to give astronomy a foothold in that country. VLP's are currently underway in Paraguay and Peru.

Astronomer-Schoolteacher Meetings

As part of each IAU General Assembly, there is a one day meeting between local schoolteachers and visiting astronomers with an interest and experience in education. Typically, this includes lectures and discussion on course material and teaching resources, and attracts a hundred or more participants. Since the General Assemblies are held in many different countries (most recently Greece, India, USA and Argentina), they leave behind a legacy of enrichment for the local educational system.
IAU Colloquium #105: The Teaching of Astronomy

In July 1988, the IAU sponsored the first international conference devoted entirely to astronomy education. It was held in Williamstown, USA, and attracted 160 astronomers from 31 different countries. The presentations and discussions were broad and exciting; they ranged from consideration of curriculum content at all levels from elementary to graduate school, to practical examples and content of specific courses, demonstrations, laboratories, the role of planetaria and computers, cross-cultural issues, and the needs of developing countries. The content and spirit of the meeting have been faithfully recorded in the proceedings (The Teaching of Astronomy edited by Jay M Pasachoff and John R Percy, Cambridge University Press, 1990). It should be in every science education library, and 'required reading' for every astronomy instructor.

National Reports and Astronomy Educational Material

IAU Commission 46 publishes a semi-annual Newsletter, with special issues devoted to triennial reports on astronomy education from the 51 IAU member countries. These make fascinating reading, as they illustrate both the diversity and the common aspirations and problems of astronomy education worldwide. Other special issues include a summary of the most significant and useful books, slides, computer software and other resource material of interest to teachers of astronomy, in the major languages of the world. While such material is rather sparse in some languages and areas of the world, there is an 'information explosion' in other areas (such as North America), so some selectivity is necessary. Commission 46 is particularly interested in the problem of information resources (textbooks, journals, databases, etc) for developing countries. Several organisations in the more affluent countries have organised programmes to send unused books and journals to institutions in special need.

The Travelling Telescope

This is the most recent project of IAU Commission 46: a small telescope, with simple teaching/research instrumentation, designed to travel to different areas of the developing world for periods of weeks to months. It can be used in support of ISYA's and VLP's, and as a 'bridge' to give local astronomers and students experience with telescopes, so that they can credibly approach their own government to provide them with basic astronomical facilities. The telescope was funded by the Canadian International Development Agency (Cida). Its first assignment was the 1990 ISYA in Malaysia.

Co-ordination in General

The most important (though least well-defined) function of the IAU Commission 46 is as a meeting place for those of us who are interested in and concerned about astronomy education. Most of us are involved in many different activities in our local countries: classroom teaching, liaison with teachers and schoolchildren, popularisation, textbook authorship and review, curriculum development at all levels, etc. Thus, the insight and experience which we share with each other gradually spreads out, in a vast network, into all parts of the education system - whether by mail or by occasional personal meetings.

Current Developments in Astronomical Education

Given the diversity of cultures and curricula, it seems rather rash to single out a few developments, knowing that many others will be omitted. Consult the conference proceedings The Teaching of Astronomy mentioned above, for a more comprehensive picture.

In most countries, amateur astronomers make important contributions to public education, by organizing lectures, displays and especially 'star nights', at which people, both young and old, can experience the thrill of viewing the moon, planets and stars through a telescope - often for the first time.

These events are often held in connection with International Astronomy Day, which is held each spring around the world. Amateurs bring a sense of enthusiasm which conveys, very effectively, the excitement of modern science.

In the US, the National Science Foundation's Education Directorate (which has a budget of the order of $300 million) is funding several interesting astronomy education projects, the first and foremost being Project STAR (Science Teaching through its Astronomical Roots). This project has developed materials (including inexpensive apparatus and hands-on activities) designed to overcome basic student

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misconceptions about the universe around them - how the solar system is arranged, how it moves, and how this produces phenomena such as day and night, and seasons. Project STAR conducts workshops for teachers, and publishes a newsletter. For more information, contact Project STAR, Center for Astrophysics, 60 Garden Street, Cambridge MA 02138, USA.

The Astronomical Society of the Pacific (390 Ashton Ave, San Francisco CA 94112, USA) is an international non-profit scientific and educational organisation which plays a major role in astronomy education through its non-technical journal Mercury, its free teachers newsletter The Universe in the Classroom, and its high quality slides, videos and other teaching resources. This material is well-suited for school courses, and for the descriptive astronomy courses offered in North American universities. The ASP also publishes informative brochures on controversial topics such as UFO's and astrology, and practical topics such as computer software.

In Mexico, astronomy educators have worked hard to overcome the problem of the cost of books by producing simple, inexpensive but factually accurate 'comic books' on astronomy. These are distributed, in large numbers, to schoolchildren. This is an effective and promising solution to the problem of obtaining accurate, up-to-date resource material at a reasonable cost.

In Europe in general, there are hundreds of 'public observatories' which support both public and school education, as well as research by both professional and amateur astronomers. These institutions have no real counterparts in North America. Planetariums were developed in Europe, and adopted widely in North America, where they are found in many schools (but not always with teachers who know how to operate them, and make them part of the science curriculum). North America was, however, the birthplace of the portable 'Starlab' planetarium, which can be transported easily from one school to another.

In France, astronomers and teachers have cooperated effectively for two decades, through CLEA: Comité de Liaison Enseignants Astronomes. CLEA supports teachers by providing practical knowledge through summer schools, and a journal Les Cahiers Clairaut, by developing practical activities, and encouraging teachers to share their experience in teaching astronomical concepts. Contact Professor L. Gouguenheim, Observatoire de Paris, Section de Meudon, 92195 Cedex, France.

Further Information
I would be pleased to provide more information about astronomy education to any interested reader. You can also contact IAU Commission 46 through the IAU Secretariat, 61, avenue de l'Observatoire, F-75014 Paris, France.

About the Author
John R Percy is Professor (Astronomy) and Associate Dean (Sciences) at the University of Toronto's Erindale Campus, Mississauga Road, Mississauga, Ontario, Canada L5L 1C6. He is active in astronomy education at all levels, from the local to the international.
An Introductory Look at Curricula and Examinations Worldwide

by Dr Jack B Holbrook
Executive Secretary, ICASE

This article is an extract from a report by the same title, prepared by ICASE in fulfillment of a contract with the Science and Technology Section, Division of Educational Development, Unesco.

Introduction
The report examines curricula and examinations around the world and indicates similarities and trends. It is based on data submitted by science teacher associations worldwide and from a review of selected curricula and examination papers in the documentation centre of Unesco, Paris.

Many factors influence the acceptance and implementation of a curriculum or syllabus, including staff development, institutional development, resources, research and planning. With so many crucial parameters, it is easy to appreciate that curriculum development is not an easy task. Systems and approaches adopted in developing curricula in the past may have a strong influence on new developments with a result that little discernable difference is seen between new and old syllabuses.

The terms 'curriculum' and 'syllabus' are used interchangeably in many countries. This report does not set out to distinguish the terms. As a guideline, however, the term syllabus is used where a teaching program or scheme of work is outlined (very often a document referring to examinations would be considered a syllabus, in this case an examination syllabus). The term curriculum is used where more comprehensive information is made available on goals, teaching approaches, available support for the teacher, etc.

Education in many countries is very competitive, especially at the senior secondary level. This has meant that science curricula at primary/junior secondary levels have tended to prepare students for curricula at the senior secondary level, which in turn have prepared students for science programs in the tertiary sector. Thus many primary science curricula have tended to be geared towards developing a basis for students to be future scientists. This has continued in the junior secondary school where factual learning is encouraged by the setting of selection examinations using pencil and paper techniques.

There seems to be two main emphases in science education - one is 'science for all' and the other is 'science for continuation'. As suggested in Education for Capability: the Role of Science and Technology Education (British Council, 1989):

"The former is concerned with the level of scientific or technological literacy expected of all primary school or junior secondary school leavers, the latter with ensuring that a proportion of the most talented young people continue with science or technology through polytechnics or universities, and use their discipline in the whole range of science and technology based careers, including teaching."

It would be useful to determine how far curricula in various countries are moving towards a 'science for all' approach (as encouraged in the world declaration made in Jomtien at the Education for All Conference, 1990). Further, it would be useful to consider how far syllabuses from various countries go beyond a mere list of topics and consider support for the teacher, the role of the school, resources, and evaluation. The full report:

- lists main syllabus topics for selected countries from Asia, Africa, Europe, America, Australasia;
- comments on these syllabuses in terms of their movement towards a 'science for all' approach;
- comments on the support given beyond the curriculum topics;
- comments on the examination system and its appropriateness.

Overall Trends
This summary relates to a small section of curricula in existence around the world. It would be useful to examine the following conclusions in the light of wider information.

1. Academic science
Little evidence of newer trends existed in most of the countries examined. Curricula continue to promote 'science for the scientist' irrespective of the aspirations of the student, and continue to be developed from an academic base rather than consider societal values and links with other subjects.

2. External examinations
Teaching tends to be governed by external examinations which tend to emphasise the recall of facts, especially in Africa. Questionnaire comments overwhelmingly suggest that assessment is neither valid nor reliable as examinations concentrate on factual recall or academic conceptual learning with little relation to societal aspects.

3. Teacher assessment
The questionnaires provided evidence that teacher assessment of theoretical and practical aspects of science were taking place, although its validity was questioned. Teachers seem more at ease with the reliability of an external system than those in teacher training.

15
or curriculum development - the views presented in the questionnaires depended on who gave them. Where Science Teacher Association views were apparent, they seemed to favour assessment by a range of methods as well as assessment of practical work.

4. Teacher guidance

There is little indication that the term 'curriculum' is taken to mean any more than 'syllabus'. Little guidance appears to be given to the school, the teacher or the student on the teaching and learning of science. In some cases the textbook is the reference, and the syllabus refers to specific chapters.

5. Evidence of change

Some change is discernable at the junior secondary level with some recognition that science is a subject that is important for all students and that it should be playing its part in preparing students for society. Such change is often accompanied by a greater degree of support for the teacher in terms of resource materials, suggested teaching strategies and, in at least one case, a recognition that teachers should be treated as professionals and be expected to play their role in the curriculum process.

This need for change seems to have been recognised in some countries that continue to adopt an academic approach, as suggested by the move towards themes and topics as unit headings rather than science concepts. However, whether intended or not, the syllabus content itself remains academic and geared towards 'science for continuation'.

6. Upper secondary level

At the upper secondary level, curricula indicate that science is taught as a preparation for continuation where a sound conceptual base is important. Practical work seems to receive greater emphasis at this level.

7. Technology education as part of science education

There is little evidence of technology education being incorporated as part of science education. Any reference to technology is usually in the context of applied science and related to applications of science principles.

8. Societal emphasis

Societal concerns associated with values education tend to occur, if included, in junior secondary courses. Values education is extremely rare in senior secondary courses. Where societal ideas do occur they are usually included in units at the end of a course rather than in the context of focusing on issues and teaching science on a need to know basis.

9. Teaching approaches

The dominant teaching approach is usually not specified but, with the syllabus being academic in design and the examination papers stressing understanding, it can be speculated that the dominant teaching approach is didactic. Very few syllabuses seem to have been made shorter in response to any concern that teachers should not be forced to use a didactic approach, faced with a formidable content syllabus.

10. Deterrents to change

There is no evidence that introducing equipment lists and sets of science equipment into schools would dramatically change the current situation. It would appear that a dramatic change in the implementation of curricula is needed before teachers would have the confidence to move away from a knowledge-based, didactic emphasis. An important requirement would probably be a change in the assessment system, enabling assessment to assume greater construct validity with respect to teaching objectives.

To be continued . . .

The next issue of Science Education International will feature comments on specific countries in Africa, Asia, Australasia, Caribbean, Europe and North America.

Science Education in Iceland

by Allyson Macdonald

This article is an extract from a project proposal submitted to the Science Foundation of Iceland.

Science education has gone through many changes in the last decade. The causes of these changes are many - for example, new practices in schools, issues in society, and results arising from research.

The changes in school practices could be considered to be a reaction to trends in curriculum development work in the 1960s and 1970s. At this time, materials were usually developed and disseminated by small groups of experts working together at a project centre. In some countries these experts were scientists; in others they were experienced teachers. Now teachers and schools take an increasingly active role in producing their own materials and curricula. Thus teacher centres and teacher advisors have increased in importance in the implementation of curricula.

The distribution of and attitudes to information have changed markedly in recent years. Personal computers, interactive videodiscs and satellite transmissions have given the general public untold access to data banks and events. Using this information demands imagination, knowledge and healthy common sense. Computer-operated devices are common in our daily environment - in the home, in the classroom and in the workplace. At the same time, environmental matters have received increasing attention within and among many nations. Excellence in science education can influence the way in which individuals and nations use the newest technology and participate in the debate on the environment.

Research on the way in which students learn has increased greatly since the mid-1970s and is already affecting the organisation of courses in science. Despite this, there is still a large gap between research on teaching and research on learning. Research in both areas indicates that effective teaching practices and thus the way in which students learn is culture-dependent. The organisation of courses within a subject area should consider the classroom, the individual, the discipline and the medium to be used.

In the last twenty years new science materials have come into use in Icelandic schools, sometimes as a precursor of a new curriculum and sometimes as a consequence. Teacher
centres have sprung up nationwide, and teacher advisors offer support, especially in the areas of special education and Icelandic. Even so, support for science teaching in the educational districts hardly exists, despite the indications that such support can be more beneficial than summer inservice courses, which are nevertheless well attended. Preservice teacher education is to become a four year course, and work is in progress on flexible teacher education programs for rural areas.

With regard to the changes which are taking place in the education system in Iceland and the fact that Icelanders should keep pace with other nations with respect to technological change and environmental matters, it seems desirable to appraise the status and role of science education in Iceland. The advantages of such an appraisal are three-fold.

One would be the chance to analyse the connections between the main parties concerned with science education. Another would be to view Icelandic science education in an international context and so facilitate international contact. The third advantage would be that such an appraisal would provide the basis for purposeful research in science education in Iceland.

Dr Allyson Macdonald has been a science and mathematics primary teacher adviser at the District Education Office in Northwest Iceland, a teacher and teacher adviser at Holar Agricultural College, and a member of the governmental working group appointed to carry out a survey of science achievement in primary schools.

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US Soviet Conference of Science Teachers  
by Dr Kenneth R Roy  
ICAPE North American Representative

From 31 July to 2 August 1991, 800 teachers from the USSR and the USA attended the first US-Soviet Conference of Science Teachers at Moscow State University. The purpose of the Conference was to provide an opportunity to explore the different science education systems, their methodologies, issues and innovations. More importantly, it provided a forum for professionals from two distant cultures to interact and share.

Each day opened with a plenary session featuring a prominent US or USSR scientist addressing topics in science and science education. After the plenary sessions, five 50 minute sessions by educators from the US or USSR focused on a variety of issues relevant to science education. Participants were able to select from approximately 20 different presentations each hour, all delivered simultaneously in English and Russian.

ICASE Special Projects Officer Professor John Penick (USA) helped to oversee the conference planning and implementation. ICASE North American Representative Dr Ken Roy (USA) presented a session titled "Preparing For and Effecting Change in Schools: Initiatives for Science Leaders and Advocates".

American participants were able to tour Moscow and Leningrad to view the culture and history of the USSR in these areas.

Russian science programs exist at the elementary and secondary levels. At the elementary level, emphasis is placed on the discussion and reading about science. Little or no attention is given to hands-on science approaches. Russian elementary teachers were most receptive to learning about activity oriented programs in the USA.

At the secondary level, science is taught throughout the grades in a spiraling curriculum. Approximately ten experiments a year are conducted by students in science classes. Teachers instruct six teaching periods per day for 45-50 minutes each. Although textbooks are primarily in a narrative format with few pictures or other illustrations, exceptional displays have been developed depicting various aspects of science. These are available for viewing and study at universities and museums.

Special schools for gifted and talented students have been created during the past two years. In addition, computers have been introduced into schools.

Many new contacts have been made between Russian and American educators with the hope of continuing dialogues and exchanging work through letters, electronic mail and possibly other visitations.

It is the hope of all conference participants that future conferences can be arranged.

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CASTME Awards

Teachers, advisers, etc working in primary, secondary and tertiary education in Commonwealth countries are eligible to enter this award program, either as individuals or syndicates.

Entries can be based on reports of original work carried out by the teacher/official, which include a substantial account of teaching and/or other educational work such as curriculum development or programs of teacher training.

In addition to a small money prize donated by CASTME, a few travelling fellowships may be awarded, courtesy of the Commonwealth Foundation, to enable prizewinners to follow a short program of professional visits in a Commonwealth country.

Judging is based on the following criteria: (1) evidence of originality and creativity; (2) evidence of use in practice and cost effectiveness; (3) evidence of evaluation of the idea and material in use; (4) evidence of the social relevance of the project; and (5) standards of presentation, organisation and structure of the report.

Registration must be made before 30 November 1991 to your local British Council office. Entries from registered candidates must arrive no later than 1 March 1992 at the Education and Science Division, The British Council, 10 Spring Gardens, London SW1A 2BN, UK.

Write to the address above to request a Registration Form.
Global Systems Curriculum Being Developed in USA

by Dr Kenneth R Roy
ICASE North American Representative

A major area of concern over the past five to ten years has been the issue of global warming. This issue not only concerns the United States, but the global community in general. Science educators in the US are concerned about the potential changes which may follow well within the lifetime of their students.

In this way, efforts are underway to introduce the issue as a curriculum topic. Given the potential implications of such a long term event, this topic goes well beyond the borders of the science curriculum. It is truly a 21st Century issue which needs to be addressed as an interdisciplinary program.

Given this scenario and having a profound commitment to helping students understand and possibly better prepare themselves for potential changes in climate, Dr Richard Golden founded the Climate Protection Institute. The Institute has broadened its resources and services over the past three years with several major initiatives which have the potential to help shape future curriculum development in this area over the next decade.

A most important project is presently underway, resulting in part from the efforts of the Climate Protection Institute. In concert with Dr Golden's efforts, the University of California at Davis received a grant from the US Department of Energy to coordinate scientific research on global warming. Included was an educational component which will be a Global Systems Science Course. The course will address development of text material and experimental research activities. The target audience will be high school students, including those students who are reluctant to take chemistry or physics. As can be expected, the course will have an interdisciplinary nature. At present, the course Global Systems Science will have five major thrusts including:

- The problem of global warming
- The climate system and life
- Energy use and conservation
- Ecological systems
- The ozone problem

These units can be taught as one course or be infused into existing biology, chemistry, physics, earth science, or social studies classes. A pilot version of materials will be printed in the fall of 1991.

As noted, the course will include the causes and consequences of both global climate change and the ozone layer depletion. It is planned that each student will construct a personal world view of the Earth and human life as an interactive system, and recognize its consequences for individual decision-making. The text will include descriptions of the most recent research and problems in trying to analyse the complex phenomena. Given the global warming and ozone depletion concerns, the political issues involved will also be addressed.

The Climate Protection Institute also provides a newsletter - the Greenhouse Gas-ette. Among other items of interest are classroom activities offered for teachers to begin their work with students in this area. The Institute has also developed other means of helping to educate students about the potential for major climate change and its implications.

Given the international significance of this issue, science teachers and science education leaders need to take an active role. ICASE could serve as a means of providing networking efforts in this area.

Anyone interested in additional information relative to activities in the US on Global Studies can contact Dr Richard Golden, Global Systems Science, Lawrence Hall of Science, University of California, Berkeley, CA 94720, USA.

Regional Meeting in Africa

The Nigerian Federal Ministry of Education hosted an African Regional Meeting in Lagos, Nigeria on 24th July on the theme Resuscitation and Strengthening of Interaction and Cooperation among Science Educators in Africa. This meeting was held as part of the larger International Council of Education for Teaching (ICET) Assembly which was held from 21-27 July 1991. Five countries - Ghana, Zimbabwe, Cameroon, Egypt and Nigeria - participated in the meeting.

Training and education in marine sciences

Excerpts from Supplement to ims Newsletter No 53/54

Unesco's varied training and education activities executed by the Division of Marine Sciences, have been pulled together into a cohesive program referred to as TREDMAR - an outcome of the report Year 2000 challenges for marine science training and education worldwide. Over 5000 copies of this Unesco publication have been distributed in six languages.

Outputs of this program include a computer based learning module Some marine applications of satellite and airborne remote sensing and a video based learning module on the identification and biology of Reef corals and sponges of Indonesia.

Serious concern about the lack of attention to marine and coastal aspects in many secondary school curricula around the world was expressed during the workshop in Paris, July 1988 at which the preparation of the Year 2000 report culminated. Consequently, recommendations were adopted in this regard by the workshop participants. A marine science field study workshop for Pacific secondary school teachers was held in Fiji in 1989. A 90 page text Field work in marine ecology for secondary schools in tropical schools has been published as MARINF/80. Contact Unesco for further details.
OPINION FORUM
The World Population Explosion
and Related Issues
A PROJECT OF THE INTERNATIONAL ASSOCIATION OF SCIENCE CLUBS
The Firs, Southdown Road, Freshwater Bay, Isle of Wight PO40 9UA, UK

Young people throughout the world are invited to complete
this opinion survey and to return it to the address of IASC above

1. There are now more people alive in the world today than have ever lived in
total before: (a) Is this idea new to you? (b) Do you believe it?

2. There are more than 5,000,000,000 people alive today, and the population
explosion curve shown on this page shows no sign of levelling off:
(a) Do you see this as a serious matter?
(b) Should nature be allowed to take its course, or should measures be taken to
help the curve towards a steady level? (Underline the option you support)
(c) List the main consequences you think go with overcrowding.
(d) What population control measures do you think are acceptable?
(e) What population control measures you think are not acceptable?

3. (a) Do you agree that the greater the number of people, the less the room for
wildlife? (b) Does this concern you?

4. (a) Would you like to have children of your own in time?
Or (b) how many children do you already have?

5. How many children would you like to have?

6. In view of world overcrowding, how many children do you think you should
have?

7. Assuming that it is desirable for all people to have a fair quality of life, and
that this does not go with overpollution and exhaustion of resources, what do
you consider to be the optimum level for the world's human population?

8. Please state your:
(a) age
(b) sex
(c) locality (town, county or state, country)
(d) country of birth

Are you interested in attending an International Young People's Forum planned
for Paris in July 1993 at your own expense? If so, please provide your name and
address to IASC at the above address.
Middle Schools and STS: An Ideal Match
by Barbara S Spector
University of South Florida, USA

This paper compares hallmarks of middle school philosophy to characteristics of STS curricula with which I am familiar. Examples are given of ways to use different STS formats to link the sciences (natural, mathematical, and social) to technology, to the humanities, and to the arts creating a transdisciplinary curriculum that is meaningful to middle level students. The examples given come from projects with which I have been working in Florida.

Characteristics of Middle School

Appropriate middle schools build on a holistic view which focuses on helping transescents learn to make connections among separate pieces of information and events. Therefore, middle school science not only integrates earth, physical, and life science, but connects to subject matter in all disciplines. Teachers working in transdisciplinary teams create opportunities for students to experience continuity from one class period to another.

Instruction focuses on the individual recognising that each child has a personal learning style and is interested in his/her own real world issues and problems. Students are helped to clarify their values and deal productively with the emotional and social aspects of life. The curriculum is exploratory and focuses on learning for today. Emphasis is on decision-making, thinking creatively and critically, and generating multiple ways to solve a problem.

Teachers share in the advising of students and instruction is deliberately designed to give students opportunities to experience success. Grades reflect the student's personal growth ascertained by a variety of procedures. Intended outcomes for students include learning how to learn (not just take tests), becoming self propelled learners, developing physically and mentally healthful life styles, having career awareness, and becoming active citizens.

Characteristics of STS Curricula
The characteristics of STS curricula with which I am familiar are consistent with the preceding characteristics of middle schools that are tailored to the needs of transescents. STS curricula build on a holistic world view. Knowledge and skills from many disciplines are integrated to construct concepts which reveal the whole. All the natural, mathematical, social, and information sciences are connected to technology forming a coherent curriculum in which the disciplines articulate with each other via a transdisciplinary approach.

Transdisciplinary refers to the disciplines being woven together into a whole in such a way that they lose their discrete identities. It is only upon deliberate analysis that one can identify the items found in the lists of mandated skills and knowledge or scope and sequences that drive courses in conventional disciplines in traditional schools.

Transdisciplinary approaches contrast to interdisciplinary approaches in that the latter often relate disciplines to each other in formats which maintain clearly defined discipline boundaries (see Figure 1). Commonly, everyone teaches what they have always taught, but they bridge to other disciplines by acknowledging when something is covered that also appears in another discipline (eg metrics, graphing, spelling). Another interdisciplinary strategy is for teachers in different disciplines to agree to follow a particular pattern (eg everyone starts from the smallest part and builds to the larger whole, or vice versa). This results in parallel tracks among conventional discrete disciplines.

Understanding relationships among people, things, and ideas is vital to students if they are to be effective in today's fast changing world. The nature of this knowledge, its connections and complexities, require a transdisciplinary approach to teaching and learning.

In STS curricula, topics are selected from real world issues and events of interest to students. They, therefore, readily perceive the relevance of what they are studying. Instruction
emphasises inductive reasoning and is experiential. Activities are open ended, have more than one right answer, and have more than one way to determine a viable answer. Students' guide the paths of lessons.

STS activities require risk assessment, cost/benefit analysis, environmental impact analysis, trade-offs, and decision-making. The needs of individuals and diverse groups with vested interests are considered when decisions are made. The interaction of values people hold derived from ways of knowing other than science, such as religion, philosophy, or aesthetics become part of the data explicitly considered in the decision making process. The scientific enterprise is portrayed as a dynamic human endeavour: a part of the global society in which changes in science and technology affect decisions people make, and the decisions people make affect further scientific and technological developments and the future of our planet.

Format for STS Curricula
A transdisciplinary approach to STS can use a variety of organizers for curriculum, all of which provide natural linkages with other disciplines (see Figure 2). Some examples of possible formats include organising a curriculum around (a) topical themes, (b) site exploration experiences, (c) themes unifying the sciences, (d) current events in the news, and (e) the history and philosophy of science and technology. What follows are samples of STS formats linking to other disciplines from successful projects with which I have been working.

Topical Themes
Topical themes, such as water, communication, or the circus work well as STS organisers. Water was selected as the unifying theme in the World of Water, a residential middle

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**ICASE AWARD SCHEME**

for outstanding contributions to international science education

_Nominations for these awards must be forwarded by member associations of ICASE. For full details of how to forward nominations, contact the Executive Secretary below._

**ICASE Distinguished Service Award**

This award is made to individuals who have a career history of distinguished service to international science education through their involvement in the international activities of local, regional and global science education organisations

**ICASE Regional Service Award**

This award honours individuals who have made a significant contribution to international science education through their involvement in international activities at the local and regional levels

**ICASE Association Award**

This award recognises individuals who, within their science teacher association, have made a significant contribution to the international activity of their association

Contact Dr Jack Holbrook, Executive Secretary ICASE
Department of Curriculum Studies, University of Hong Kong, Hong Kong
school program, because the uniqueness of fresh water on planet earth is what makes life as we know it possible (Spector, 1991). Water is an ideal theme around which to build a program for students to acquire the knowledge and skills necessary for solving real world problems.

One way the natural, mathematical, and social sciences and technology were woven together was through laboratory and field experiences addressing the problem of the economic impact of developing ways to supplement nature's filtration system to maintain adequate supplies of potable water in Florida, given the state's population explosion (900 new residents/day).

Dance, music, and the visual arts were all used as vehicles to teach key concepts and principles in the sciences. Free flow writing was used in personal logs as a vehicle to help students construct knowledge through reflection. More formal expository writing formats were practiced as they recorded data from the field investigations and the laboratory, used technical writing for research proposals, and used persuasive writing for an essay contest.

Haiku poetry, creative drama, and role play were used to identify incomplete conceptions and assess students' abilities to synthesise what they had learned from their opportunities to gather data on the properties of water and the role of water in both natural and human settings. Using other disciplines as vehicles to learn science helped students develop a holistic world view consistent with an understanding of the strengths and limitations of the scientific enterprise.

If we select topics students associate with leisure time activities, such as fishing, sailing, photography, etc., when using topical themes as organisers, and study the science and technology inherent in the activity students perceive learning to be relevant. It also makes success experiences readily available to youngsters because they can build on the knowledge they have gleaned informally through their recreation. For example, in the World of Water, we use sailing to study Bernoulli's Principle and wave motion in physics and hull and sail design to study materials chemistry and mathematics. Fishing is the vehicle for learning the physics of a rod, reel, and monofilament line. Finding good places and times to fish involve the study of food chains, habitats, and meteorology. Literature of the sea, fish stories from the comics to the classics, provide insight into ways people around the world have learned the science and technology that students are learning from their own experiences.

Site exploration experiences

Site exploration experiences (SEE) are excursions to locations in the community for in-depth studies of real life situations. Activities at a site are developed to meet the perceived needs of a specific group of students. Any place has potential to be a SEE from an open field, to a manufacturing plant, to a theme park. SEEs provide a common base of experience for students who may have very different life experiences and few things in common around which to interact and build concepts. The common experience serves as the cameo around which teachers from all disciplines develop classroom activities, thus establishing continuity from one class period to the next during a day. The social interaction and cooperative learning outside the confining structure of a classroom help students develop their personal skills while learning science. In addition, SEE's make it easy for teachers to abandon the 3Ts (Teacher, Talk, and Textbook) and use a mosaic of instructional designs including role playing, simulations, debate, varieties of computer programs, mapping (V, concept, and theory), individual projects, small group activities, and group presentations.

Here are edited excerpts from reflective logs kept by teachers in a middle school during the first year in which they began converting from a junior high school to a middle school (Spector, 1990). The team leader and initiator of the school's holistic approach to curriculum was a science teacher steeped in STS

A nine week theme title, WDIIDWWDW - What do I do with what I don't want? - connected to the SEE at a sewage treatment plant.

Students were told things to look for at the sewage plant by teachers from each discipline. Ratio and proportion were the key ideas for mathematics. Geography focused on sewage treatment and disposal as a community-wide and world-wide issue. Science dealt with the environmental impact of sewage disposal and with the study of zooplankton and methane gas. A teacher played the keyboard and taught the students to sing a song which describes the relationships between pollution and the lowest part of the food chain. For English, students were asked to act as reporters. They recorded their observations and later wrote about their experiences at the sewage plant. Students generated concept maps of the SEE as an evaluation.

Figure 2

SAMPLE STS CURRICULA FORMATS

STS Curriculum may be organised around

1. Topical themes
2. Site exploration experiences
3. Themes that unify the sciences
4. Current events in the news
5. History and philosophy of science

22
A nine week theme on communication revolved around the SEE at the local newspaper. Students had made recycled paper earlier in the year before the site exploration. The technology of the printing presses and the multiple uses of computers at the newspaper plant impressed them. They were coached on questioning techniques before they visited the newspaper plant.

In English, they had discussed various methods of asking questions and discovered that more information could be obtained by avoiding questions that required a single word answer, such as yes or no. Students enhanced their speaking skills while they practiced interviewing each other. The students also practiced questioning and listening skills in mathematics, science and geography. Developing a line of questioning with which to investigate a topic is critical to systematic inquiry in all disciplines. The geography teachers helped students explore the various sections of the newspaper.

The day following the SEE, students were asked to write in their journals in English. They were free to write whatever they wished about their experience. Some leading questions were offered as possibilities to stimulate thinking, such as "How was the experience different from what you expected?" "What did you find most interesting?" and/or "What was something new you learned?" Prior to the trip, this is what a student had written about the newspaper: "It's black and white and comes in a plastic bag". His journal entry after the trip covered half a page.

In English class, they also cooperatively wrote a thank you note to someone at the newspaper. In each group individuals took the role of editor, proofreader, reporter, and scribe. Students understood a group grade would be given, and each student had to contribute to the total grade. Groups were randomly selected. Within the group, it was decided who would handle each job and to whom they would write. Students in every group contributed ideas on what to write and the reporter recorded the ideas. The editor had the final say as to what should be in the letter, and the scribe wrote it. The proof reader checked the letter and made any necessary changes. It was then rewritten and checked by the editor who gave it to the teacher to mail. The students were very vocal about anyone who did not take part in this activity. At the same time, there was always someone in the group who took up the responsibilities of a 'slacker'. Peer pressure effectively encouraged nonparticipants to join in a learning experience.

Themes unifying the sciences

The relationships about which students need to know, their interactions and intricate connections, suggest organising information around themes which describe the relationships of the extant body of knowledge. A variety of such themes pervade the sciences, the humanities, and the arts and work well as organisers for STS curricula. For example, in the BSCS middle school project (1989), Science and Technology: Investigating Human Dimensions themes such as patterns of change, limits and diversity, equilibrium, evolution, energy and interdependence are used. Science for All Americans: Project 2061 (AAS, 1989) suggests organizing themes this way: Systems; Models - physical, conceptual and mathematical; Constancy - stability and equilibrium, conservation, symmetry; Patterns of change - trends, cycles, chaos; Evolution - possibilities, rates and interactions; and Scale.

While these themes are being publicised because they run through the natural sciences, they are also evident in other disciplines traditionally taught to middle level students in schools.

For example, in English classes patterns of change are noted as one traces the development of language and
culture from Shakespearian English to current slang.

In literature, patterns of change are studied in the characters from the beginning of a story to the end. Social studies classes explore patterns of change in culture of civilisations around the world. Patterns of change are studied within a musical composition, and in the passage from one era of music to another, eg classical to new age music.

In English, there are limits and diversity in writing forms from styles of poetry, to essays, to technical reports. In social studies, acceptable social behaviours differ and are limited by the variety in cultures. In mathematics, limits and diversity can be seen in the difference between the arabic numbers and Roman numerals, Euclidian geometry and non-Euclidian geometry, Newtonian calculus and non-Newtonian calculus, and the existence of multiple ways to solve a mathematical problem.

Career awareness initiatives, such as having students solve anthropometric problems in architecture, illustrate the holism of using the theme of scale in STS curricula. One has to combine mathematics, art, and human science to create functional architectural designs. For example, we have to know how human elbow joints work in order to design drawers that can be pulled out or how human body parts articulate when one designs a comfortable chair, or establishes the height of steps. Scale is a theme that also ties the study of ratio and proportion in mathematics classes to mapping in geography classes.

Other forms

Current events in the news lend themselves equally well as transdisciplinary STS organisers, especially events reported for their local impact while they are part of global issues. For example, newspaper reports of local families being separated as troops left for the Gulf War, or reports of a foreign owned corporation applying to a governing body in rural America for permission to burn hazardous waste in a cement kiln, illustrate how real world problems require an understanding of the interaction of science, technology and society and the weaving together of knowledge from numerous other conventional disciplines to reach resolutions with world-wide implications.

The history and philosophy of science and technology is another format that works well as an STS organiser. A historical approach to which students are very receptive is the televised version of Burke's (1978 and 1985) Connections and The Day the Universe Changed.

Summary

After studying the needs of transcents (11-14 year olds) and the subsequent nature of schooling that would meet their needs, I concluded that STS is an ideal core upon which to build schooling for middle level youngsters. The characteristics of the STS initiatives I've experienced match the philosophy of the middle school visionaries. Further, STS provides natural linkages to all other disciplines taught in a school. Science teachers who use STS approaches readily take the lead in restructuring the many separate disciplines in their schools into an articulated, coherent, transdisciplinary whole which is considered to be the desired state for schooling of middle level youngsters (Spector, 1991).

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Multicultural Science Education by Practicing Teachers
A Model with International Implications
by Anjana Arora & Elizabeth Kean

Access and Appropriateness

According to the Indian National Policy on Education (1986): "In our culturally plural society, education should foster universal and eternal values, oriented towards the unity and integration of our people. Such value education should help eliminate obscursism, religious fanaticism, violence, superstition, and fatalism." This Policy further stated: "The new Policy will lay emphasis on the removal of disparities and will equalise educational opportunity by attending to the specific needs of those who have been denied equality so far." These groups of people with specific needs have been identified as women, schedule castes, schedule tribes, people in backward areas, religious minorities, linguistic minorities, handicapped, adult learners, etc. This Policy also stressed decreasing dropout rates.

One cannot help but be struck by the parallels between the stated problems and goals in the Indian educational system and many other worldwide locations. In the United States of America the number of students from various ethnic backgrounds (primarily African American, Latino, Native American, and some recent Asian immigrants) who are interested and successful in schools is intolerably low. High school dropout profiles also correlate with ethnicity and poverty. In 1982, high school dropout rates were reported as 14% for whites, 24% for African Americans, and 40% for Latinos. These children, many of whom are poor, are effectively cut off from careers in science and technology - just the types of jobs most likely to offer them financial security.

Moreover, as a society, the percentage of US youth who are members of a minority group is rising dramatically. By the year 2000, 1 in 3 Americans will be minority and the proportion of minority students of school age will approach 50% (Hodgkinson, 1985).

In both countries, the problem comes down to two issues: access and appropriateness. Are children able to get to schools and, if so, is the education they receive appropriate? It is this latter issue, the ability of children to make use of the education offered by the schools, that we would like to address in this paper.

Cultural Matches

Many factors contribute to the failure of minority youth to pursue learning in school, and especially learning in science. Given the structure and the content of traditional science classes, many of these students cannot perceive the relevance of what they are being taught to their current or future lives. The culture of many minority students does not match well the white, middle class social and instructional school paradigms, for example an emphasis on individual performance, the passive nature of school work, the valuing of knowledge possession over human relationships. As a result, minority children often fail to engage in the work of the school.

We cannot overlook the societal factors that produce uninterested science learners. Rather, teachers must learn to change the culture of their schools in order to bridge the gap between where students are when they enter and where we wish them to be when they leave. This will enable more minority students, especially poor children, to thrive in school science, preparing themselves to participate fully in the civic and economic life of our nation (Bryk and Driscoll, 1988; Comer, 1988).

Moreover, although it is important to train the up-coming generations of science teachers to teach in culturally appropriate ways (O’Brien, 1991), it is even more necessary to support the current group of science teachers to change their practice. Below are some of the issues that must be addressed in supporting practicing, experienced teachers' growth in multicultural science teaching.

Changing the School Science Teaching Culture

Over the past two years through our observations, interviews with teachers, administrators and students, we have identified the following needs for change in the school culture:

1. Teachers report that a persistently large number of their students fail to engage in science learning. Such students appear to be uninterested, angry or bored. It is not that these students cannot learn, but rather that they are choosing not to learn. These students will not suddenly transform themselves into model students. If there is to be a change in science learning, it will come about because teachers find a way to change their own behavior, setting a new context in the classroom in which students find it harder to stay unengaged, uninterested, angry or bored. Such changes involve changes in teacher attitudes as well as
how and what content is presented. 

2. Teachers cannot teach what they do not know. Many teachers rely primarily on texts for their content knowledge. Such text knowledge is often out of date with respect to current issues and knowledge in science. Further, it is often alien and unengaging to the targeted students. Teachers need to develop content knowledge that is accurate, relevant to students, and which promotes problem solving skills and scientific literacy.

3. Many science teachers have control of traditional pedagogical skills that work well with compliant, willing students who have been well socialised into the traditional school culture. These traditional teaching strategies are often not effective with unengaged students. Teachers need to develop a wider variety of teaching strategies specific to their courses.

4. Because the problem of unengagement is complex, the response must be complex. New content, new strategies, new ways of working cross culturally need to be developed concurrently. Our experience to date is that teachers have more trouble changing the content from text-focused to problem-focused, than with any of the other needed changes.

The Process of School Science Cultural Change

We believe that in order for these changes to be implemented, teachers must be co-creators with program staff of much of the new curricula and teaching methods, and that they must learn to implement them in real multicultural classroom settings. Moreover, administrators from their schools must likewise be knowledgeable about the changes and willing to support them. In the past two years, much new science content for use in multicultural settings has been developed by participating teachers during four week summer workshops. In preparing teachers for their role as curriculum developers, the 1989 and 1990 summer workshops had the following objectives:

- participants develop new understandings of the characteristics (strengths and needs) of minority students and how to respond to those characteristics.

- participants develop new understandings of the power of problem-solving and cooperative learning approaches, singly and in concert.

- teachers plan and implement new course materials for their own classes, based on these understandings.

- administrators develop procedures to support implementation of these materials by teachers.

- participants develop outreach programs to inform others of new strategies which have been effective in their classes.

The major themes of the workshop are described as follows:

- Multicultural Understandings

   Presenters from various ethnic groups lead participants to confront issues of ethnic differences and similarities. Activities help participants to understand their own cultural base as well as to understand and value cultures different from their own. Participants examine some of the cultural biases that influence interactions among minority and majority people and develop ways of responding more flexibly and creatively with minority students. Special attention is given to minority students' needs for nurturing relationships as a foundation for effective learning (Bryk and Driscoll,
1988; Comer, 1988). Participants interact with the minority communities and with minority children to provide a greater experiential base for developing multicultural sensitivities.

**Problem Solving**

Problem solving consists of 3 P’s; problem posing, problem solving, and persuasion of peers (Peterson and Jungck, 1988). Among the topics considered are: problem solving approaches to algorithmic and non-algorithmic problems, heuristics useful in varying contexts, development with students of interesting science questions with attention to science issues in their lives, strategies for teaching problem solving, etc. (Middlecamp and Kean, 1987; Reif, 1983; Rubenstein, 1986). Teachers consider problems which are part of their current science courses, as well as problems that introduce new topics for study. Teachers are taught the question: "Why would any student want (need) to know that?" as the ultimate question to be addressed when planning new content.

**Cooperative Learning**

Cooperative learning has been shown to enhance the performance and integration of minority students in the classroom. It is a learning mode that increases achievement as it develops appropriate social interaction skills among students (Johnson, Johnson, Buckman & Richards, 1985). Therefore, it is an effective method of instruction to enhance racial integration within classrooms (Johnson & Johnson, 1984). During the workshops, participants learn to use the five essential elements of cooperative learning - positive interdependence, face to face interaction, individual accountability, collaborative skills, and group processing (Johnson, Johnson & Holubec, 1988). They experience many cooperative learning situations and develop teaching plans that incorporate cooperative learning. The technique is highly interactive, integrating concepts of coaching and learning styles with methods of explicit instruction.

These three themes are highly interrelated and they were taught in the workshops in an integrated manner.

Although each instructional activity of the workshops addressed a specific theme, aspects relating to the other themes were brought in as appropriate. For example, the first days of the workshops focused on ethnicity issues. However, the learning characteristics of various ethnic groups were further discussed during segments centered on problem solving (What problems might be of interest to minority students?) and cooperative learning (How can strengths of minority students be utilised in a cooperative learning activity?).

Participants spent much of the 17 days of the workshop constructing teaching units incorporating ideas from these themes. After having been introduced to the themes through a variety of experiences and exercises, participants designed a short instructional unit (2-3 days). Participants worked in groups, focusing on topics from their science texts, but using problem solving and/or cooperative learning strategies as the instructional framework. Each group worked cooperatively to solve the problems of selecting content, assigning roles to group members, etc. Units were critiqued by the entire group (for ethnic sensitivity, alternatives to "telling" by teachers, problem solving focus, multiple level goals, etc).

Participants later designed a 2-3 week unit. Topics were generated in a brainstorming exercise and categorised into clusters. Once general areas were identified, participants self selected to work in one of the areas. The groups which formed through this process were mixed with respect to schools, subject areas, and grade levels.

Learning in these units often is assessed in ways other than by pencil and paper tests and conventional grades. All units were developed on computer so that they could be easily shared with other teachers.

The organisation described above is non-traditional. For example, issues were not presented linearly, but were treated repeatedly in ever more complex ways. Administrators, some not trained in science, involved themselves in developing science units with teachers. The response by participants to the workshops has been overwhelmingly positive, as evidenced by their journals and responses to formal and informal evaluation instruments.

In addition to the summer workshops, follow-up during the academic year is vital and has assisted teachers in maintaining connections with one another and working through implementation problems. Project staff visit each teacher's classroom at least once per semester and discuss specific problems and successes the teacher has encountered. The entire group gathers quarterly for a half day to discuss implementation patterns and plan new activities, including dissemination to teachers unable to attend summer workshops.

**What Next?**

Over the next three years, projects in the following areas are planned:

- Continue to plan new curricula, especially to provide new content information and integrate problem based modules into cohesive themes.
- Conduct on-site visits to other science curriculum improvement projects in the region (AAAS, 1989; NSTA, 1990) to share expertise in producing effective units and activities.
- Refine instructional methods of teaching the new content and teaching strategies to other teachers.
- Plan and conduct in-services for teachers unable to attend summer workshops.
- Develop links with external communities to enhance science content, career contacts, and minority resources.
- Develop computer capabilities to enhance management and networking skills of participating teachers.

The intent of this phase of the project is to consolidate the changes in the science classroom culture and to institutionalise those changes throughout the school system. Only then will systematic change take place, reaching all of those students who have in prior years been largely failed by the system.

**Applicability to the international context**

The workshop described above is an example of collaborative effort between
university researchers and school people. Workshops like this enable teachers to discuss their own needs and use their own resources to meet these needs.

As teachers analyse their problems they will be able to find many direct and indirect ways to tackle these problems. Researchers can work further on the teacher experience-generated issues, cementing the partnership between teachers and researchers. Teachers will be more willing to be involved in issues they have generated.

The success of such an effort depends upon how often these teachers exchange ideas. Where possible the teachers involved should be from the same geographical area so that they can meet often in order to exchange their successes and failures and to come up with new issues.

One of the main constraints in conducting or applying research is the availability of funds. On the other hand, whatever funds are available can be utilised in a more effective manner. Rust and Dalin (1990), based on a number of research articles and UNESCO publications related to Asia, state:

"... that conventional teacher training and upgrading programs have little or no impact on student learning, that they are generally irrelevant to teacher needs and conditions, and that they are longer and more costly than necessary."

Conventional programs, while not always ineffective, are costly. Hence teachers, teacher educators, and researchers (including researchers from fields such as Psychology, Sociology, Political Science, Natural Science) must pool their internal and external resources for improving both conventional and non-conventional approaches.

In getting together, teachers, teacher educators and researchers can understand, recreate and analyse their problems within the framework of their working conditions.

It is up to teachers to decide how they can best tackle a problem within the constraints (fixed curriculum, teaching for an exam) of their working conditions. We do not visualise a direct or immediate global change from efforts such as this. As educators and teachers, however, we can influence our immediate surroundings.

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**Pasteur and Microbes**

*A Teacher Resource Book*

*Commemorating the 100th Year of the Pasteur Institute 1888-1988*

This valuable resource book (166 pages) provides information about the activities and facilities available at the Pasteur Institute. It contains a variety of science experiments relating to the action of soil microbes, yeast as a food-making microbe, micro-organisms in milk, making cheese, making vinegar, and making wine, to name just a few. These activities are appropriate for secondary science teaching. Emphasis is on useful micro-organisms, food production and food preservation.

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Helping Primary School Teachers Help Children in Science

by Dr David Palacio
School of Education
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Introduction of a Science National Curriculum in England in August 1989 had two important features as far as primary schools are concerned. First, science became a mandatory part of the curriculum for all children during their primary school years. Second, for many of those schools who were already introducing children to some form of science education, a shift towards a greater emphasis on developing children's understanding of science concepts was required. This latter point has very important consequences for the effective delivery of this curriculum since it was not known whether, or to what extent, primary school teachers themselves have the required knowledge and understanding of the relevant concepts to be able to competently and confidently introduce them to children.

The Primary School Teachers and Science (PSTS) Project, a joint venture between the University of Oxford Department of Educational Studies and Westminster College, Oxford, has been set up with the major aim of helping teachers acquire the knowledge and understanding of the concepts central to science at a level which will enable them to introduce these concepts effectively to primary school children. Two projects have been set up under the PSTS umbrella, both funded by Charitable Trusts.

The first project is investigating teachers' existing understanding of science concepts and using this information as a starting point for the production of teacher education materials aimed at further developing conceptual understanding. Concepts chosen for detailed investigation were those that were known to cause difficulty for primary teachers. Hence the work began with the concepts force, energy and change in materials; later work focused on a range of biological concepts such as respiration and photosynthesis, and concepts associated with the Earth and atmosphere and Earth in space.

The second project is investigating whether the theory of and approach to learning employed in developing and writing these materials (constructivism coupled with metacognition) can be effective in bringing about long term conceptual change in adult 'non-science' learners.

This article deals with the first of these projects and describes the process by which the teacher education materials have been developed.

Finding out teachers' existing understanding of targeted science concepts was accomplished via a three phase process. In the first stage, a small number of teachers (about 20) were interviewed using a procedure known as 'interview about instances / interview about events' to find out in some detail the nature of their existing conceptual understanding in the targeted conceptual area. The second phase used some of the ideas that emerged from the interviews as a basis for the construction of a multi-choice questionnaire that was completed by around 150 teachers per conceptual area. Taken together, both phases formed a fairly reliable basis from which to go forward to the next phase - the production of teacher education materials.

During both the interview and prevalence phases, other background information was collected from the teachers (such as their experiences of science in school and during their professional training) and was subsequently fed into the materials production phase. This whole procedure was repeated for each of the conceptual areas in the list above, with the addition that, for some conceptual areas, a technique known as concept mapping was used to supplement the information obtained during the interview phase.

Even though the materials are set within a constructivist - metacognitive approach to learning in science, background information gathered during the interview and prevalence phases led the project team to reject...
Moving on Air

From SATIS 8-14
Association for Science Education, UK

These activities will help you understand why moving on a bed of air is so easy.

The Air Track

Make an air track with a plastic drink bottle, using a compass point or thumbtack to make holes as shown.

Make a 'vehicle' by cutting a plastic ring from another larger bottle. Make sure the ring has no ragged edges.

Put the ring over the holes in the air track.
Blow into the bottle and watch the vehicle move along freely.
How much weight can you put on the vehicle?

The Balloon Hovercraft

Make a model like this.
Blow up the balloon and see how it moves.
Can you make your hovercraft bounce off things?
The 1991 Singapore Youth Science Fortnight

by Sue Stocklmayer
SMEC, Curtin University of Technology
Perth, Western Australia

The Singapore Youth Science Fortnight is an annual event sponsored by Shell Companies in Asia and Australasia. Each year, one science teacher from Australia accompanies two students to Singapore for a succession of activities with a science theme. In 1991, Emma Runciman, from St Paul's Anglican Grammar School in Warragul (Victoria) and David O'Connor, from Heathfield High School near Adelaide (South Australia) were the Australian student delegates. Emma and David were Science Talent Search winners in their respective States; Emma for her "Phoeboscope" and David for his "Bedroom Control Interface".

Centre. Dr Gore delivered the Keynote Address which was enthusiastically received by Singaporean teachers.

The main focus of the fortnight was the Science Fair, an occasion at which the international student delegates were expected to explain their projects and talk to the public. Emma's and David's projects attracted considerable attention and a constant stream of visitors, but we nevertheless found time to visit some of the local students' displays.

The Fair this year was for primary students in Singapore; next year it will be the turn of the secondary schools. It was an absolute delight to talk to these very small children about the principles underlying their projects; from the Bernoulli Effect to Global Warming, they were able to explain exactly what their experiment was all about.

The fourteenth Science Fortnight had as its theme "Values in Science Education". Its stated aims were:

- to provide young scientists with an opportunity to discuss scientific problems and the implications of science on society, both among themselves as well as with senior members of the scientific community, and;
- to allow educators of youths to exchange views and experiences in science education.

There were eight nations present - Singapore, Thailand, Brunei, Indonesia, Malaysia, Philippines, New Zealand and Australia. From first to last the organisation was superb. We attended dinners, sang Karaoke, and generally had enormous fun. It is impossible to list all that we did; suffice it to say that we really felt that we had got to know Singapore and its people in a special way.

The most important outcome of the fortnight was, for Emma, David and me, the interactions we had with the students and the teachers of the participating nations. We were together most of the time, sharing both work and recreational activities, and there was plenty of time to make friends. There is no doubt that the Youth Science Fortnight is a notable event on the calendar of science education, and we are indeed fortunate that Shell Australia so freely offers its support.

We have brought back not only memories of a wonderful experience (and the addresses of many new friends!) but a greater understanding of some of the strengths and some of the problems which other countries experience in science education, and a knowledge of many difficulties which we share.

Events such as this can only result in more interaction, more help, and more global understanding.
The Special Topics Club
Extra-Curricular STS Activities

by Dr. Michael J Demchik & Dr. Virginia C Demchik
Jefferson High School
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Science Technology Society (STS) activities are an excellent way of bringing real world learning into the classroom. In our recent and on-going revisions in chemistry and physics at Jefferson High School, West Virginia, STS is incorporated at the 20% level. While we consider that the resources used are excellent, we also feel that another element - career education - can be incorporated into this format easily.

Early in the school year, students at the junior and senior level in Chemistry I, Chemistry II, and Physics, are surveyed in order to determine their projected fields of endeavour. (Other items are examined as well with this survey but the career education portion is the only part reported in this article.) The individual data is developed into a composite, and student interests are determined. Each year the results are much the same and the numbers vary slightly. From the data the most frequently appearing fields are the engineering, medical, biological and physical sciences (infrequently physics). Others appear to a lesser degree.

At a date prior to the initial survey work three years ago, a letter was sent to governmental agencies, state agencies, college and university staff, and a few companies, requesting their help in arranging for someone who would be willing to informally present to our students, information about his or her work.

Additionally, we requested each participating individual to prepare an activity in which our students could participate. The activity had to represent something that they did in their work which was suitable for high school level. The list has grown to 55 resource people, including professors, researchers, and practitioners of science.

Individuals were selected from this list based on the student survey results. Resource people have presented topics on robotics, lasers, oscilloscopes, electromagnetic induction, aquaculture, motors, raptor centres and more. As a result of these presentations, some field trips were developed which took us to places such as the National Fisheries Laboratory, where we toured the laboratories and had a short talk by the member of staff responsible for each lab. One interesting aspect was the work being done to research a specific hybrid fish that would be suitable for the conditions in the nearby Potomac River.

Another visit involved the Chemistry Instrumental Laboratory at nearby Shepherd College. The laboratory director arranged for some of his advanced students to demonstrate the types of equipment available, and provided our students with the opportunity to operate them. We were able to borrow a Beckman Acculab 3 Grating Spectrometer, and an Aldrich-Nicolet Search Program for the Apple IIe computer to use with the aqueous section of the Chemistry course.

Another development has been to involve graduates of our program who are now majoring in specific areas, by having them visit the school to discuss their work at college/university level. For example, one student, a raptor centre volunteer for two years, brought some birds that were strongly imprinted on humans.

In the past nine years, we have placed nine students at the National Fruit Lab as research apprentices. Two others worked at the Soil Conservation Service. With the help of this program, students are gaining a better view of their chosen career and, as a result, they are proceeding to college/university with more confidence. The program, well received by our students, supports STS objectives so necessary in today's world.

About the authors
Dr. Michael J Demchik, with 32 years experience in administrative and teaching positions, has been teaching chemistry and physics for five years at Jefferson High School. Dr. Virginia C Demchik has been teaching at college and secondary level for 25 years, and has been at Jefferson High School for the past five years.

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Science across Europe

Reprinted from the Newsletter June 1991
of the Science across Europe Project

Why 'Science across Europe'?

As the countries of Europe move closer together, it is important to raise the awareness of European citizens for one another's societies.

Europeans have many traditions and languages, but they hold in common a culture of scientific values and beliefs. Pupils in schools across Europe follow similar science courses.

It is a common experience in most countries that the most effective way of introducing new educational topics is to tie them closely to the curriculum. The Science across Europe Project sets out to provide opportunities through the science curriculum for 14 to 17 year old students to share their ideas.

Intended outcomes

The project is producing a series of short units (lessons) for use with the science curriculum for 14 to 17 year olds. The units are translated and adapted to make them appropriate to each of a range of European countries. Each unit is based on a science-related issue, selected according to the following criteria:

- the extent to which the issue affects students throughout Europe
- the extent to which it links mainstream science curriculum topics.

The project has already established a successful formula for student material. In its second year it will be seeking to improve the arrangements for contacts between classes and to involve more schools and languages. Its major challenge will be to arrange distribution of published material.

Phase 1

Phase 1 took place during 1990. Trial versions of two units were produced in seven languages.

The development team consisted of eight people drawn from educational establishments representing six countries in Europe. A general strategy for the project was agreed. The team drafted two short units in English, Acid rain over Europe and Using energy at home. A feature of the units is that students need to contact other schools in Europe to exchange data and ideas. Members of the team undertook the translations and adaptation into German, French, Dutch, Swedish, Spanish and Catalan.

Trials took place in early 1991 with about 50 schools participating.

An evaluation study was undertaken by Harrie Eijkelhof of the University of Utrecht. Teachers reported that their students had enjoyed receiving information from students in other countries and learning about their perspectives. They were keen to undertake similar work in the future. There seemed little difficulty fitting the units into the regular science curriculum.

Phase 2

In this phase the project will develop on a modest but more formal basis. We began work in April 1991.

In phase 2 we aim to:
- increase the number of languages in which we work
- extend the network of schools using the materials
- develop and trial three new units

The writing team, enlarged to 10 members, met for a weekend workshop in Brussels during April and made the following recommendations:
- to publish the units developed during last year as two books (for September 1991)
- to set up a database of schools wishing to participate in the network (for November 1991)
- to write and trial three new units: Renewable energy, Water quality and What did you eat ... ? (These are temporary titles). These units will be ready for publication in September 1992.

Each unit will be published as a single book containing all its language versions to provide opportunities for further language work in schools. The books will be available for purchase from organisations such as the Association for Science Education, UK and for distribution through the BP network.

Feedback from trials identified a need to harmonise the timing of contacts between schools. With the new publications we hope to refine our procedure. Schools will be able to join
the Project's network or arrange their own contacts. BP will also operate a network for schools linked to local sites around Europe. We would like to offer a choice of periods during the year for exchanges of information between schools.

Initially, we anticipate that distribution of the new books will present the greatest challenge to the growth of the Project.

In some countries, schools do not have budgets to spend on books, and formal administrative procedures are too lengthy to be overcome during the year of phase 2. We therefore propose to distribute 50 free copies of each book in such countries. The remaining copies would be offered for sale.

Even so, no country has an organisation comparable with the ASE (Association for Science Education, UK) that can handle distribution, and BP has offered help.

The Project will need to establish permanent channels of distribution for the future.

A typical unit

'Acid rain over Europe' is a survey of the acid rain problem in different countries, and a comparison of different perspectives. Students contact those in other countries to collect information on the nature of the acid rain problem, the measures being taken to counter it, and their perspectives on where the blame lies.

Students then evaluate the subjective information they have collected by comparing it with a collection of factual data for different countries on, for example, production of sulfur dioxide, prevailing winds and average pH of rainfall. They can thus get a view of differing perspectives and evaluate them based on hard fact.

Science across Europe units

Available September 1991

- Acid rain over Europe
- Using energy at home

Trial versions available November/December 1991
Publication September 1992

- Renewable energy
- Drinking water
- What did you eat . . . ?

Collaborators

The project has been initiated by the Association for Science Education (ASE) in collaboration with British Petroleum (BP). ASE has close links with science teaching associations in most European countries, and with the International Council of Associations for Science Education (ICASE).

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NEW ICASE PUBLICATION

Industry - Education Liaison

ICASE YEARBOOK 1990

Based on a symposium held in Brussels
5-7 September 1990

The 1990 ICASE Yearbook, sponsored by CEFIC (Conseil European Des Federations De L'industrie Chimique), is a timely publication. The collection of papers presented at the Seminar on Industry-Education Liaison acknowledges the critical importance of partnerships between industry and education. The Seminar, held from the 5th to 7th September 1990, was organised to: (1) provide opportunities for the exchange of information and experiences in schemes for industry-education liaison; (2) develop models for industry-education liaison; (3) establish, through ICASE, a network for information exchange for future developments; (4) publish a resource book for teachers and administrators on industry-education liaison.

The Yearbook addresses a variety of topics, for example: An Overview of Demographic Trends in Industry; Chemical Industry Education Centre; Exciting Science and Engineering; Cologne Model: Chemistry-Technology-Everyday Life; Contact between School and Working Life in Sweden; Forms of Cooperation between the Chemical Industry and Secondary Schools in the Netherlands; and The Planning and Organisation of Industry Study Tours. A Summary of Seminar Discussions outlines some key principles and proposes a course of future action.

Copies, at a cost of US$7.50 or £4.50 plus 25% postage, can be ordered from:

Dennis Chisman, Honorary Treasurer, ICASE
Knapp Hill, South Harting, Petersfield GU31 5LR, UK
Cheques payable to "ICASE"
Science and Technology Education in Africa

Focus on seven sub-saharan countries

Edited by Duro Ajeyalemi

This book has been compiled to bridge the knowledge gap about science and technology education in sub-Saharan Africa. It will be of interest to science and technology educators, student teachers, planners and policy makers in education and in science/technology, and all those in a position to contribute effectively to the improvement of science and technology education in Africa, including aid agencies.

The Editor has contributed an article Science and Technology Education in Perspective which examines the African situation in the light of worldwide trends. The following chapters, written by eminent African scholars, present a detailed analysis of past, present and future trends in science and technology education in each of the seven countries - Ghana, Lesotho, Nigeria, Swaziland, Uganda, Zambia and Zimbabwe. The final chapter Science and Technology Education in Africa: A Comparative Analysis and Future Prospects, concludes that much still needs to be done, and proposes suggestions for addressing the common problems unique to sub-Saharan Africa.

Published by University of Lagos Press, 1990
Unilag Post Office Box 132
University of Lagos, Lagos, Nigeria

Marine Science Resources

from the Division of Marine Sciences
UNESCO, 7 place de Fontenoy
75700 Paris, France

A video-based learning module on the identification and biology of Reef corals and sponges of Indonesia has been produced. It consists of a 3.5 hour video with underwater filming of numerous species and computer simulations of reproduction, growth, etc. It is available in PAL (VHS and Betamax) and NTSC (VHS) formats, and is accompanied by a 65 page text (MARINF/75).

The Division wishes to ensure the widest possible distribution of these materials to the targeted teacher/student community.

Therefore, modules are provided, free of charge, to "primary" recipients (individuals, institutions, associations, etc) with the request that they in turn make copies of the material and make them available free of charge to interestd third parties.

Call to readers
Information is sought on any other marine science learning materials in existence or being finalised, using:
- computer based
- video based
- or similar advanced learning technology.

Some examples of this type of material are already listed in Annex 6 of the Unesco report Year 2000 challenges for marine science training and education worldwide.

Please send to:
The Division of Marine Sciences
Unesco
7 place de Fontenoy
75700 Paris
France

Scientific and Technological Literacy: Education for Change

by Jane Bowyer

This is a special report generated in the context of the World Conference on Education for All, 5-9 March 1990 in Thailand. The author stresses that scientific and technological literacy must be given priority as an essential component of basic education by:
- examining the nature of science and technology as human activities
- analysing why basic education needs to be broadened to include science and technological literacy
- defining essential areas of scientific and technological knowledge and skills necessary for basic education.

The 39 page report is available free of charge from: ED/EDV/STE, Unesco, 7 place de Fontenoy, 75700 Paris, France.
ICASE is keen to arrange regional or world events for the benefit of member associations. If your association or organisation is interested in hosting an international seminar, workshop or conference, contact the Executive Secretary or your Regional Representative. To gain ICASE endorsement, the meeting must be international in nature, open to member associations, and, while all sectors of the science education community should be encouraged to participate, must be relevant to classroom teachers.

1991

September 14-16
Conference on Teaching About the Protection of the Environment
Location: Krakow, Poland
Contact: Alicia Wojtyna-Jodko, Chairperson, Organising Committee, Stowarzyszenie Nauczycieli Przyrodniczych i Technicznych (SNPPiT), Skrytka Pocztowa 62, 85791 Bydgoszcz 32, Poland
This general interdisciplinary conference of teachers will be the first annual meeting of natural science and technology teachers active in institutions of education at the elementary and secondary levels, together with people from academic institutions with a vested interest in scientific and technical education. During morning plenary lectures, researchers will present the directions of research in ecology, chemistry and physics relevant to the theme. In afternoon sessions, teachers will join small group discussions focusing on sharing examples and experiences. The working languages for discussion will be English and Polish. The first general assembly of SNPPiT (Association of Science and Technology Teachers) will discuss the future of this new association and elect officers. A meeting with a delegate of the Ministry will provide an opportunity for discussing the need for improving the level of scientific and technical education in Poland in light of the experience of other countries.

September 16-20
EURYSN Training Seminar
Location: Science and Nature Centre, Sivry, Rance, Belgium
Contact: John D McGrath, European Youth Science Network, c/o ECO, 11 Cope Street, Dublin 2, Ireland
Youth science workers, volunteers in EURYSN organisations, and others interested in youth science activities (under 25 years of age) are invited to the first major training event of its kind in Europe. The aim of the Training Seminar is to introduce new people and organisations to Youth Science activities and programs, "Science in Society" education programs, and different techniques in informal science education for young people.

1992

November 6-10
NABT Annual Convention
Location: Souffier Hotel, Nashville, Tennessee, USA
Contact: Patricia J McWethy, Executive Director, National Association of Biology Teachers, 11250 Roger Bacon Drive, #19, Reston, Virginia 22090, USA
The next annual convention of the National Association of Biology Teachers will focus on the theme Form and Function: How Should They Be Taught. Applications for program space are due on 15 March 1991.

November 21-23
NSTA Area Convention
Location: Vancouver, British Columbia, Canada
Contact: Director, Meetings and Conventions, 1742 Connecticut Ave, NW, Washington, DC 20009, USA
Canada is the venue for this Area Convention of the National Science Teachers Association.

January 3-6
ASE Annual Meeting
Location: University of Sheffield, Sheffield, UK
Contact: Annual Meeting Secretary, ASE Headquarters, College Lane, Hatfield AL10 9AA, UK
Full details of this large international event will be circulated in Education in Science, a journal of the Association for Science Education.

March 26-29
NSTA National Convention
Location: Boston, MA, USA
International delegates are invited to participate in the International Round Table - one of the many features of this large convention. Each country is provided one or more tables in a large room where delegates can display and present information on science education in their country. Visitors move from table to table, talking with the various representatives. If you require an invitation to participate, write to John E Penick, Professor and Coordinator, Science Education Center, The University of Iowa, Iowa City, Iowa 52242, USA.
March 29 - April 10
Seminar on Science Teacher Education
Location: Centre for Educational Studies, King's College London, UK
Contact: Courses Department, The British Council, 10 Spring Gardens, London SW1A 2BN, UK
This British Council International Seminar will be directed by John Head and John May of King's College Centre for Educational Studies, University of London, and will focus on secondary level teacher education, although some aspects will be of interest to those involved in primary science teaching. Six areas will be addressed: What is the nature of science education for schools?; To what extent should teacher education reflect and shape societies' values and cultural traditions?; How can we aid their professional development so that science teachers have the skills they need in the classroom and laboratory?; What can the results of research tell us about new ways to approach children's learning and classroom practice?; How is the work of pupils, teachers and trainees to be evaluated?; How does the structure of national and regional administration affect the management of teacher education? There are vacancies for 30 international participants - practising teacher trainers, advisers, inspectors, organisers of professional development programs and policy maker.

April 26-May 1
International Conference on Technology Education - INCOTE 92
Location: Weimar, Germany
Contact: Dr D Blandow, INCOTE 92, Pädagogische Hochschule, Nordhäuserstraße 63, 0-5063 Erfurt, Germany
This symposium will be the first pan-European meeting on technology education to be held in Germany. The principal aim of the symposium, which is being organised in collaboration with a number of organisations including ICASE and INISTE, will be to discuss technological literacy and competence in technology education within a European dimension. The majority of participants will be from European countries, with a few key people from other regions of the world. The principal language of the symposium will be English.

May 11-15
Second International History Philosophy and Science Teaching Conference
Location: Queen's University, Kingston, Ontario, Canada
Contact: Prof Skip Hills, Faculty of Education, Queen's University, Kingston, Ontario, Canada K7L 3N6
This conference follows the very successful First International Conference on History, Philosophy and Science Teaching held at Florida State University in November 1989. All conference papers will be published in advance of the conference. Accounts of the application of history and philosophy of science in the science classroom are welcome, as are research papers on the issue.

May 11-22
Seminar on Developments in Primary Science Education
Location: Liverpool, UK
Contact: Courses Department, The British Council, 10 Spring Gardens, London SW1A 2BN, UK
This British Council Seminar will examine major concerns and activities in primary science in the UK as well as their international context and implications. Major research and development projects in the area of science and technology relevant to the primary phase will be represented, including Learning in science, Research into children's ideas, Contexts of learning, Out of school learning, Curriculum development and evaluation, Pupil assessment, and Teacher education. There are vacancies for 35 participants, including science educators and curriculum developers concerned with the primary phase.

June 10-12
ICASE Research Seminar on Chemistry and Physics Education
Location: University of Dortmund, Germany
Contact: Prof Dr Hans-Jürgen Schmidt, University of Dortmund, Department of Chemistry, Otto-Hahn-Straße, 4600 Dortmund 50, Germany
This symposium on empirical research in chemistry and physics education will focus on the methodology of empirical research in this field. There will be approximately 12 presentations each followed by a discussion period. The language of the symposium will be English. Presenters will be asked to send their paper beforehand, ready for printing as Proceedings through ICASE. Proposals of about 3 pages should include title, background, method, results, discussion, implications for research and teaching, and references, and should be sent to the contact above no later than August 31, 1991. General papers will not be accepted. Although there will be no seminar fee, participants will need to cover their own expenses.

July 6-10
CONASTA 41
Location: Perth, Western Australia
Contact: Convenor, CONASTA 41, Science Teachers Association of WA, PO Box 991, West Perth, WA 6005 Australia
The Australian Science Teachers Association invites you to participate in the forty first annual conference of the Association.

August 2-10
Eighth ICASE Asian Symposium
Location: Colombo, Sri Lanka
Contact: Mr Asoka Weerasinge
Hon. Joint Secretary, SLASME, Institute of Computer Technology, PO Box 1490, Colombo, Sri Lanka
Science educators are invited to attend the eighth ICASE Asian Symposium and enjoy the natural beauty of the country and the hospitality of the Sri Lankans. The Symposium, organised jointly by ICASE and the Sri Lanka Association for Science and Mathematics Education
(SLASME), will feature outstanding speakers from many countries who will address the theme "Science Education for a Changing World". The Symposium aims to identify some of the changes affecting our daily lives and to discuss ways by which science education can respond to these changes. Subthemes include (1) technology, (2) appropriate technology, (3) environment, and (4) scientific literacy. Participants will be able to experience the world famous pageant "The Kandy Perahera" in Sri Lanka.

August 31 - September 3
SCICON Biennial Conference of NZSTA
Location: University of Waikato, Hamilton, New Zealand
Contact: Neal Utting, Education Advisory Service, 4 Hill Street, Hamilton, New Zealand
The theme of SCICON for 1992 will be Science - Technology ... A Partnership. Information and registration forms about the biennial national conference of the New Zealand Science Teachers Association can be obtained from the contact above.

December 17-21
Twelfth International Conference on Chemical Education
Location: Bangkok, Thailand
Contact: Dr Somjai Wichaidit, The Secretariat - 12th ICCE, c/o Research Centre, Faculty of Medicine, Ramathibodi Hospital, Rama 6 Road, Bangkok 10400, Thailand
The theme of the Twelfth International Conference on Chemical Education will be Chemistry in Transition and it is hoped that the participants will interpret this in many different ways. This biennial Conference, to be held for the first time in South East Asia, is organised by the Committee on Teaching of Chemistry of the International Union of Pure & Applied Chemistry, and The Chemical Society of Thailand in cooperation with UNESCO. It is attended by chemistry teachers at both high school and university levels who wish to improve their teaching and to learn from one another techniques and experiences. A second circular including instructions for submitting abstracts and registration will be mailed in March 1992 to those responding to the address above.

1993

January 3-8
International Conference on Science Education in Developing Countries
Location: The Amos De-Shalit Israeli Science Teaching Center, Israel
Contact: Conference Secretariat, ORTRA Ltd, 2 Kaufman St, PO Box 50432, 61500 Tel-Aviv, Israel (conference arrangements) or Dr Avi Hofstein, Department of Science Teaching, The Weizmann Institute of Science, Rehovot 76100, Israel (academic correspondence)
This international conference on the theme "Science Education in Developing Countries: From Theory to Practice" will review past experiences and achievements in science education and plan for the 21st century with a special focus on developing countries. The conference will feature plenary lectures, symposia, poster sessions, workshops, exhibitions, informal discussions, social events and local visits. Topics for symposia and plenary lectures will focus on current research on learning and teaching and its implications for (1) the learner, (2) the teacher, (3) the classroom, and (4) the curriculum.

June 27 - July 3
VII Pacific Science Inter-Congress
Location: Okinawa Convention Center, Okinawa, Japan
Contact: VII Pacific Science Inter-Congress, c/o Section of International Affairs, University of the Ryukyus, 1-Senbaru, Nishihara, Okinawa, 903-01, Japan
The Symposia will be organised around the theme The Pacific: Crossroads for Culture and Nature and subthemes (1) Cultural Interchange among Pacific Peoples; (2) Speciation, Dispersal and Conservation of Species in the Pacific; (3) Towards Appropriate Technologies and Policies for Development and for the Conservation of Natural Environments in the Pacific. Scientific sessions organised by the Scientific Committees of the Pacific Science Association focus on a range of science disciplines and issues, including Science Communication and Education.

APOLLO 11
A Teacher Resource Book

Commemorating the 20th anniversary of the Apollo 11 Moon Landing, this ICASE publication provides activities for primary and secondary science students. Send US$10 or £6 plus 25% postage to:

Dennis Chisman, ICASE Hon Treasurer
Knapp Hill, South Harting
Petersfield GU31 5LR, UK
Cheques payable to "ICASE"
Extending and improving education in science
for all children and youth by assisting
member associations throughout the world

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College Lane
Hatfield, Herts AL10 9AA
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Mr Brenton Honeymon
Editor, ICASE Journal
10 Hawken Street
Monash ACT 2904
Australia

ICASE - supporting science teachers around the world
Science Education International is the Quarterly Journal of the International Council of Associations for Science Education. ICASE was established in 1973 to extend and improve education in science for all children and youth by assisting member associations throughout the world.

This journal provides a means for associations, institutions, centres, foundations, companies and individuals concerned with science education, to share perspectives, concerns, ideas and information which will foster cooperative efforts to improve science education, and which will serve as a chronicle of the advancement of science education throughout the world.

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Maris Silis, Australia
Sue Dale Tunnicliffe, UK

**Correspondence:**
Brenton Honeyman
Editor, The ICASE Journal
10 Hawken Street
Monash ACT 2904
Australia

**Dates for Receipt of Contributions**

<table>
<thead>
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<td>December</td>
<td>1 November</td>
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**ICASE News**

**Feature Articles**

Secondary school biology in the USSR  V I Sivoglasov
Chemistry diagrams: A cross cultural study within a constructivist framework  A Wheeler, D Hill, J Oladotum
Future directions of sustainable development in the curriculum  D Chisman, J Holbrook, C Devan

**Science Education Around the World**

**Research for Teaching and Learning**

Creating a cooperative classroom  A Colburn, J Penick

**Science Teacher Education**

Portfolios: A national trend with worldwide potential  R Bonnstetter

**Primary Science**

Effect of inservice programs on elementary teachers' attitudes towards science  W Spooner, S Tunnicliffe

**Science Technology Society**

Science as part of our culture  M Gore

**Resources**

**Calendar**

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Individuals £9 per annum, Libraries £18 per annum

or to one of these subscription centres:

John Penick, ICASE Special Projects

Science Education Center, University of Iowa, Iowa City IA 52242, USA
Individuals US$15 per annum, Libraries US$30 per annum

Brenton Honeyman, Editor, The ICASE Journal

10 Hawken Street, Monash ACT 2904, Australia
Individuals A$20 per annum, Libraries A$40 per annum
ICASE Caribbean Regional Conference
Trinidad and Tobago
August 27-30, 1991

This report was compiled by Judith Reay, an ICASE Award Winner who attended the Conference as Co-Editor of the Conference Proceedings.

The ASETT-ICASE Conference 91 was held at the University of the West Indies, Trinidad and Tobago, from August 27 to 30, 1991. The theme of the Conference was 'Education in Science and Technology for Development: Perspectives for the 21st Century'.

Among the Conference participants were Dr Winston King from Barbados, the ICASE Past President, and Bob Lepischak from Canada, the current ICASE President. In his address, the President drew attention to Project 2000+, a major thrust of Unesco and ICASE on scientific and technological literacy - closely related to theme of this Conference in the West Indies.

It is expected that the Conference Proceedings will be available early in 1992. The South American/Caribbean Representative on the ICASE Executive Committee - Althea Maund (photo below) - is a member of the Association for Science Education of Trinidad and Tobago which organised the Conference.

This section provides news for the information of member associations, institutions, centres, foundations and companies. The Executive Committee encourages members to reproduce this section in journals and newsletters to communicate this information to as many as possible.

ICASE welcomes new members

St Kitts Science Association
The St Kitts Science Association, West Indies, joined ICASE as a member during the recent ASETT-ICASE Conference 91, which was held in Trinidad and Tobago during 27-30 August this year.

For further information, contact: Lincoln Carty, President of St Kitts Science Association, who is a Lecturer in Science Education in the Division of Teacher Education, College of Further Education, PO Box 268, St Kitts, West Indies.

American Chemical Society
ICASE welcomes the American Chemical Society - a large and active professional organisation in the USA - as a Member Association of ICASE. Sylvia A Ware, Director of the Society's Education Division, has written that all official channels in the Society have endorsed this membership move, and are looking forward to actively participating in ICASE in the coming years.

For further information, contact Sylvia A Ware, Director, Education Division, American Chemical Society, 1155 Sixteenth Street, N.W., Washington, D.C. 20036, USA.

The number of new members of ICASE during this year has been a most pleasing aspect of the organisation's growth. For further enquiries about membership, please contact the Executive Secretary - Dr Jack Holbrook (refer to address on page 40)

Who's Who in Science Education Around the World
1991 Edition

Published by ICASE with assistance from Unesco

This biographical volume is now available from:

Brenton Honeyman, Editor
Who's Who in Science Education
10 Hawken Street
Monash ACT 2904
Australia

This new ICASE publication contains brief profiles on prominent science educators, their work, their projects and their interests. The valuable reference book includes key women and men in many countries throughout the world who are contributing to science education at primary, secondary or tertiary levels. The information will help readers to contact colleagues in both developing and developed countries who may be working on projects of interest to them, who may be potential speakers at upcoming meetings or conventions, and who may be invited to work on collaborative projects. Copies are being distributed to ICASE member associations, institutions, centres, foundations and companies, and to international science education organisations including Unesco, and the ICSU Committee on Teaching of Science.

STOP PRESS

Negotiations are currently underway to hold a second ICASE Symposium on Education - Industry Liaison in 1992

This will follow the very successful symposium organised by ICASE in conjunction with the Chemical Industry in September 1990
Eighth ICASE Asian Symposium
Colombo, Sri Lanka
2-10 August 1992

Science Education for a changing world

Organised jointly by ICASE and the SLASME

Contact:
Mr Asoka Weerasinghe
Hon. Joint Secretary
SLASME
Institute of Computer Technology
PO Box 1490, Colombo
Sri Lanka

Stepping into Science Advisory Committee

This ICASE primary/elementary science education project is currently strengthening its network through the establishment of an International Advisory Committee:

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CESI Board and ICASE Project Officer
18 Octavia, Bracknell
Berkshire RG12 7YZ, UK

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Trinity College, Kandy, Sri Lanka

Masie Southwell
Ministry of Education Youth & Culture, Church Street
St Johns, Antigua

Eustace Hill
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St Johns, Antigua

Peter Chonjo
Faculty of Education
PO Box 35048
Dar es Salaam, Tanzania

Hafiz Mohammed Iqbal, President Pakistan Association for Science Education
Department of Education, University of the Punjab, Quaid-e-azam Campus
Lahore, Pakistan

Review of Literature on Scientific and Technological Literacy

In preparation for the major Unesco-ICASE Conference to be held in Paris during 1993 as part of Project 2000+, ICASE is completing a review of the literature on scientific and technological literacy.

Please send any articles or abstracts on these subjects to:

John E Penick
Science Education Center
789 VAN
University of Iowa
Iowa City, Iowa 52242
USA

All submissions will be acknowledged in the review.

Space Science Seminar and Workshop

by R Lepischak
President, ICASE

The 1991 Space Science Seminar and Workshop held at the Lyndon B Johnson Space Center, Houston, Texas during 8-13 July 1991 was yet another outstanding success.

This year's program was attended by 140 educators from Canada, 6 from the UK, and 15 from a space magnet school district at San Antonio, Texas. The program provided rich experiences for participants and valuable educational resources — print materials, videotapes, slides, posters, and computer diskettes.

The program has fostered international links, and has been instrumental in the setting up of task forces now at work enhancing education through space science.

Plans are underway to hold another Space Science Seminar and Workshop in July 1992 — hopefully involving more delegates from ICASE member associations worldwide.

Coming ICASE Events

For further details about these ICASE endorsed events, consult Calendar in this issue.

April 26 - May 1, 1992
INCOTE 92 International Conference on Technology Education, Weimar, Germany
Contact: Dawn Robertson, Janet Jones

June 10-12, 1992
ICASE Research Seminar on Chemistry and Physics Education, University of Dortmund, Germany
Contact: Prof Dr Hans-Jürgen Schmidt, University of Dortmund, Department of Chemistry, Otto-Hahn-Straße, 4600 Dortmund 50, Germany

August 2-10, 1992
Eighth ICASE Asian Symposium, Colombo, Sri Lanka
Contact: Mt Asoka Weerasinghe
Hon. Joint Secretary, SLASME, Institute of Computer Technology, PO Box 1490, Colombo, Sri Lanka
Secondary School Biology in the USSR

by Vladislav I Sivoglasov
Moscow Pedagogical State University
Moscow, USSR

Soviet schools are preparing a new generation, ready for active participation in the process of restructuring and democratisation of Soviet society. We need well-developed and challenged persons who are well educated and aware of the necessity of self-education. Biology, now taught according to new curriculum and programs developed in 1986, emphasises learning the main biological concepts and leading scientific theories and ideas.

Concepts and leading ideas determine course content and structure and include: (1) organic world evolution; (2) interconnecting structure and function on wildlife; (3) interconnections of the biological systems with the environment; and (4) connection of theory and practice. The biology course is preceded by a course in natural history in primary and early secondary school.

3. Animals (VII grade - 24 hours; VIII grade - 68 hours)

4. Human health (IX grade - 68 hours)

5. General biology (X grade - 34 hours, XI grade - 51 hours)

The biology course at some Soviet schools isn’t divided into traditional parts such as botany, zoology, human anatomy, physiology and hygiene, or general biology. In these schools, we created an integrated biology curriculum where the contents have been simplified. And, much more attention is paid to interrelations between specialised biological disciplines.

Course content varies according to the grade. VI grade includes information on morphology, vital activity, reproduction and development of flowers, and interactions of plants and surroundings.

| TABLE 1 |
| Time for the Natural History Course in Primary Schools |

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<thead>
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<td></td>
<td></td>
<td></td>
<td>3</td>
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<tr>
<td>(starts at age 7)</td>
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<td>1</td>
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<tr>
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<td>1</td>
<td>1</td>
<td>4</td>
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<tr>
<td>(starts at age 6)</td>
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</table>

In the primary grades students study natural history, including seasons and weather, agriculture, plants and animals, and the general structure of the human body. Great attention is paid to personal and social hygiene.

Natural history in the secondary school (beginning with grade five, one hour a week) is devoted to the study of physical science, interrelations of living organisms and environment, variety of living organisms and conditions, and necessities for their vital activity.

The secondary biology course is divided into five parts:

1. Plants (VI grade - 68 hours; VII grade - 36 hours)
2. Bacteria, Mushrooms, Lichens (VII grade - 8 hours)

VII grade students study biodiversity and systematics of plants, bacteria, lichens and mushrooms and differences in their structure due to the evolutionary process.

In grades VII and VIII the 'Animals' unit gives information on the variety of animals from Protozoa to Mammals, their structure, functions, systematics, and relationships. Students of IX grade study 'Human Body and Health', which provides information on the peculiarities of the human body, its vitality, elementary first aid and also on sexual and hygiene problems.

The Unit 'General Biology', studied during X and XI grades, ends the course of biology at secondary school. This unit provides information on cell biology, genetics, evolutionary
TABLE 2
Time for the Biology Course in Secondary Schools

<table>
<thead>
<tr>
<th>Grade</th>
<th>V*</th>
<th>VI</th>
<th>VII</th>
<th>VIII</th>
<th>IX</th>
<th>X</th>
<th>XI</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours a Week</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1/2</td>
<td>10.5</td>
</tr>
</tbody>
</table>

* natural history

theory, biotechnology, ecology, and environmental protection.

After IX grade students may continue their education in secondary professional schools (3 years) or secondary special technical schools (3 years). General biology at this level is studied as an obligatory educational subject (73 and 70 hours accordingly). Students also can deepen and extend their knowledge in special groups at various extra-school Pupils' Houses, Institutes, and Universities.

In addition, the USSR State Committee on Peoples' Education worked out sixteen on biological and ecological elective courses. These elective courses start from the VII grade with students of VII-IX grades able to choose courses for two hours a week and grade X and XI four hours per week.

In the USSR programs of advanced study on different subjects are being developed. In 1986 the new curriculum on biology was designed to provide an extended theoretical and practical study of the subject. The program is introduced from the VIII grade (VIII-IX grades - 4 hours a week, X-XI grades - 3 and 3/4 hours plus 2 extra hours on studying additional units, chosen by teacher).

The main goals of studying biology at school are to:

1. ensure the mastering of main ideas of biology as a field of science (structure, vitality of the organic world, structure and function of ecological systems, and their changes due to human impact);
2. form a scientific world outlook and ensure the awareness of a humankind in the world, their place and role in the biosphere;
3. understand the practical significance of biology as the basis of agriculture, food industry, biotechnology, and environmental protection;
4. use subject knowledge for professional and career orientation;
5. form ecologically-educated people with responsibility towards nature and readiness for its protection;
6. form skills and habits necessary for people to extend their knowledge, to develop logical thinking during education and future practice.

Current liberalisation of education in the USSR allows many schools and regions to work out their own school, city or national curriculums and programs on biology. Most of

TABLE 3

Elective Biological Courses at Secondary School

<table>
<thead>
<tr>
<th>Elective Courses</th>
<th>Hours</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Life of plants</td>
<td>34</td>
<td>VII</td>
</tr>
<tr>
<td>Life of animals</td>
<td>68</td>
<td>VIII</td>
</tr>
<tr>
<td>Human physiology</td>
<td>68</td>
<td>IX</td>
</tr>
<tr>
<td>Outlines of hygiene and sanitation</td>
<td>34</td>
<td>IX</td>
</tr>
<tr>
<td>Outlines of ecology and labour protection</td>
<td>68</td>
<td>IX-X</td>
</tr>
<tr>
<td>Physiology of agricultural animals and zootechnics</td>
<td>34</td>
<td>XI</td>
</tr>
<tr>
<td>Physiology of higher nervous activity</td>
<td>34</td>
<td>X</td>
</tr>
<tr>
<td>Physiology of agricultural plants and plant growing</td>
<td>34</td>
<td>X</td>
</tr>
<tr>
<td>General biology</td>
<td>136</td>
<td>X-XI</td>
</tr>
<tr>
<td>Wildlife evolution</td>
<td>68</td>
<td>XI</td>
</tr>
<tr>
<td>Molecular biology</td>
<td>34</td>
<td>XI</td>
</tr>
<tr>
<td>Outlines of genetics and selection</td>
<td>68</td>
<td>XI</td>
</tr>
<tr>
<td>Outlines of biotechnology intersubject courses on ecology</td>
<td>34</td>
<td>XI</td>
</tr>
<tr>
<td>Human health and environment</td>
<td>34</td>
<td>IX</td>
</tr>
<tr>
<td>Techniques and environment</td>
<td>34</td>
<td>X</td>
</tr>
<tr>
<td>Man and biosphere</td>
<td>68</td>
<td>XI</td>
</tr>
</tbody>
</table>
TABLE 4
Curriculum for Schools with Advanced Biology Course

<table>
<thead>
<tr>
<th>Name of the unit</th>
<th>Hours according to the grades</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>VIII</td>
</tr>
<tr>
<td>Main units of advanced course</td>
<td>3+1</td>
</tr>
<tr>
<td>• Animals; life of plants</td>
<td>4</td>
</tr>
<tr>
<td>• A man and his health</td>
<td>3</td>
</tr>
<tr>
<td>• General biology</td>
<td></td>
</tr>
<tr>
<td>Additional units for advanced course</td>
<td></td>
</tr>
<tr>
<td>• Outlines of ecology and environmental protection</td>
<td>+</td>
</tr>
<tr>
<td>• Physiology of agricultural plants and plant growing</td>
<td>+</td>
</tr>
<tr>
<td>• Physiology of agricultural animals and zootechnics</td>
<td>+</td>
</tr>
<tr>
<td>• Wildlife evolution</td>
<td>+</td>
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<tr>
<td>• Molecular biology</td>
<td>+</td>
</tr>
<tr>
<td>• Outlines of genetics and selection</td>
<td>+</td>
</tr>
<tr>
<td>• Outlines of biotechnology</td>
<td>+</td>
</tr>
</tbody>
</table>

They are based on the state obligatory program and/or take into consideration main guidelines of biological education in the country. We are optimistic that these new programs of study will help ensure that our students are as biologically and scientifically literate as they must be to succeed in the future.

About the Author
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ICASE AWARD SCHEME
for outstanding contributions to international science education

Nominations for these awards must be forwarded by member associations of ICASE. For full details of how to forward nominations, contact the Executive Secretary below.

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This award is made to individuals who have a career history of distinguished service to international science education through their involvement in the international activities of local, regional and global science education organisations

ICASE Regional Service Award
This award honours individuals who have made a significant contribution to international science education through their involvement in international activities at the local and regional levels

ICASE Association Award
This award recognises individuals who, within their science teacher association, have made a significant contribution to the international activity of their association

Contact Dr Jack Holbrook, Executive Secretary ICASE
Department of Curriculum Studies, University of Hong Kong, Hong Kong
Science teachers depend upon diagrams to assist them in the explanation of many important scientific ideas and relationships (Wheeler and Hill, 1990). Diagrams offer the promise of making so many of the abstract ideas in science more concrete by providing an effective organiser or mental model (Mayer, 1989 and Winn, 1981, 1988). While the advantages of using scientific diagrams seems obvious, the work on visual communication in science by Barlex and Carre (1985) clearly indicates that diagrams are far more complex than we normally assume and can be a source of difficulty for learners.

Scientific diagrams are embedded in a particular conceptual framework; they are not "epistemologically flat" (Kilbourn, 1982). For example, chemistry diagrams relating to the kinetic theory of matter require an understanding of that theory for their interpretation. These conceptual underpinnings, together with an understanding of the nature and purpose of diagrams, provide an important part of the context for the interpretation for diagrams depicting the arrangement of particles in solids, liquids and gases, an almost universal topic in secondary school science programs. However, learners frequently view such diagrams as a primary source of knowledge about the scientific ideas they represent. In these cases, diagrams can lead the learner to generate minor misunderstandings or serious misconceptions. For example, diagrams in chemistry relating to the arrangement of particles associated with a phase change may misdirect naive students and lead them to construct erroneous ideas about relative densities (Wheeler and Hill, 1990). Teachers who approach science instruction from a constructivist perspective are more likely to appreciate the educational implications of such generative activity on the part of the learner (Wheatley, 1991).

Diagram 1 presents a universally common textbook illustration designed to 'explain' phase changes in terms of increased molecular motion. The diagrams are effective in conveying this idea but at the same time they over-represent the decrease in density when depicting the liquid to gas change. The inability of many students to recognise the inherent limitations of diagrams may affect students' understanding of science relationships in everyday experiences. For example, the acceptance of the above molecular model for a liquid at face value would imply that liquids are far more compressible than is the case. On the other hand, under-representing the density decrease in changing from a liquid to a gas may tend to downplay the considerable compressibility of gases. Either way, diagrams mediate in the development of students' understanding of ideas and concepts in science. This mediation process may well vary culturally according to the importance and reliance placed upon textbook learning in different countries.

Diagram 2: A Liquid Solution

Similarly, standard textbook diagrams on solutions and the dissolving process (Diagram 2) may lead to a variety of student misunderstandings (for example, the actual number of particles involved, relative size, shape and distribution of solute and solvent particles).

As a type of visual communication in science the use of diagrams is both powerful and inherently complex. Diagrams are regularly used to both supplement and complement descriptive text in order to communicate in science more effectively. Effective communication assumes, however, that students interpret the diagrams in the manner in which it was intended by the illustrator.

Most scientific diagrams are iconic representations of mental constructions. They have both a scientific component and a pictorial one. The latter involves an understanding of the manner in which relationships can be illustrated and the associated assumptions, conventions and limitations. These aspects are seldom discussed in science classes (Lowe, 1986). If this is true, then it could be predicted that students would
not be familiar with the conventions and exaggerations which follow. One purpose of this study was to test this prediction.

**Conventions**

There are a number of underlying conventions associated with science diagrams relating to the particulate nature of matter. These include the notions that:

1. Any illustration is not to be taken at face value but represents one possible arrangement at a particular moment in time.
2. What is shown in two dimensions should be considered in three dimensions.
3. Particles are represented by circles and the relationship between them can be shown by lines.
4. Particle size remains constant irrespective of state.
5. Equal volumes are represented by equal areas.
6. Unless otherwise stated all conditions are equal.

**Exaggerations**

Many texts contain diagrams which exaggerate certain aspects in order to highlight particular relationships or features (Hill, 1988). The present study dealt with the following exaggerations:

1. The decrease in density is exaggerated when a solid melts.
2. The expansion of a solid when heated is exaggerated.
3. The spacing between liquid particles is exaggerated.
4. The relative number of solute to solvent particles in a solution is exaggerated.
5. The relative number of gas to liquid particles is exaggerated when a liquid and its vapour are in equilibrium.

In addition, there are other, more subtle aspects found in scientific diagrams which may influence the ideas which learners generate. These include regularly illustrating the arrangements of particles in solids using large circles, illustrating the behaviour of liquids using smaller circles and representing gas molecules as dots. Strongly bonded particles are usually shown close together. The particles in liquids are seldom shown in contact. Covalent bonds and the outlines of crystal lattice in ionic solids are both represented in the same way by straight lines.

**Purpose of the Study**

This study investigated student interpretations of chemistry diagrams across four distinct sample groups (Australia, Canada, Malaysia, Nigeria). It was designed to determine whether secondary chemistry students from the four culture groups differed in their acceptance of diagrams at face value or whether they appreciated their intended purpose and inherent limitations.

The study focused on students' understanding of commonly used conventions and limitations of chemistry diagrams dealing with the particulate nature of matter and the Kinetic Molecular Model. The content area was chosen because it is known to be a difficult area of chemistry for many students. This difficulty is related to the abstract nature of the concepts associated with the topics and the difficulty in providing suitable material to illustrate these concepts - the very reasons why diagrams usually abound in chapters on these topics in school chemistry texts.

**Study Sample**

A total of 766 senior secondary chemistry students in four countries (Australia, N=59; Canada, N=184; Malaysia, N=363; and Nigeria, N=160) constituted the total sample for the study. While the total sample (excluding the Australian group) contained more males (58%) than females (42%), it was deemed representative of the general student population at the secondary level. Classes involved were heterogeneous in ability and had received instruction in the general topics dealt with in the diagrams. Classroom teachers associated with the study all felt that the science diagrams involved concepts familiar to the students.

**Test Instrument**

The six two-tier questions on the test instrument asked students to:

1. Select diagrams which best represent given situations (Q1, 2, 3);
2. Draw a diagram to represent a particular instance (Q6);
3. Select diagrams to best represent specific relationships (Q4, 5).

In addition, students were also asked to give a specific reason for their response to each item. The development of the instrument and details of its reliability and validity have been reported elsewhere (Hill, 1988).

**Description of test questions**

<table>
<thead>
<tr>
<th>Question</th>
<th>Focus</th>
<th>Alternatives consistent with common text diagrams</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Exaggeration 1</td>
<td>2 and 3</td>
</tr>
<tr>
<td>2</td>
<td>Exaggeration 3</td>
<td>2 and 3</td>
</tr>
<tr>
<td>3</td>
<td>Exaggeration 5</td>
<td>1, 2 and 3</td>
</tr>
<tr>
<td>4</td>
<td>Convention 4</td>
<td>1 and 2</td>
</tr>
<tr>
<td>5</td>
<td>Exaggeration 2</td>
<td>2, 3 and 4</td>
</tr>
<tr>
<td>6</td>
<td>Exaggeration 4</td>
<td>2</td>
</tr>
</tbody>
</table>

Examples of the three different types of questions are reproduced below.

**Question 3**

Exaggeration 5 - the relative number of gas to liquid particles is exaggerated.

Diagram A (i) (ii) (iii)
A certain petroleum wax boils at 230°C. Diagram A shows an arrangement of the wax molecules at 228°C. Which diagram could best represent the most probable arrangement, at a particular instant in time, in a sample of the wax vapour at 230°C at the same pressure? Tick one alternative (Refer to diagram on previous page).

Question 4
Convection 4 - Particle size remains constant irrespective of state.

Imagine that the molecules of a wax in the solid, liquid and gas states can be represented as spheres. Which set of diagrams would best represent the molecules of this wax under these conditions? Tick one alternative.

Question 6
Exaggeration 4 - The relative number of solute to solvent particles in a solution is exaggerated.

The series of circles below represent part of a dilute (2M) aqueous solution of ammonia.

Show the relative distribution of water and ammonia molecules in this solution by shading in circles to represent ammonia and leaving those which represent water unshaded.

Sample reasons for questions 3, 4 and 6 are given below together with a brief general comment.

Question 3 Sample Reason
"... at 230°C (20°C above the boiling point) the molecules (in the vapour) ... have just begun to separate and move apart from one another. In diagram (i) the molecules are too close and in (ii) and (iv) they are too far apart." (Here the student seems to have a picture of a typical 'liquid' and a 'gas' in mind but thinks of the transition as a 'gradual process' requiring a temperature higher than the boiling point to produce the dispersion of molecules characteristic of a gas.)

Question 4 Sample Reason
"Molecules in solids are arranged more tightly ... they are heavier and no spaces are found between them. However, in a liquid the molecules are lighter and capable of moving apart. Gas molecules are smallest ... and lightest and therefore easily released to the atmosphere." (Most diagrams which illustrate the arrangement of particles in solids show relatively few atoms, ions or molecules. This means the particles appear larger than in corresponding diagrams for liquids. For the nature of gases most illustrators use a large number of relatively small dots. From this data the student has constructed the above ideas.)

Question 6 Sample Reason
"The distribution in a 2M solution would be equal." (The student shaded in every circle. This item proved to be difficult. Most students failed to compute the solute to solvent ratio from the information provided and shaded in half or more of the circles.)

Discussion
The overall pattern of responses on each of the six items is fairly consistent. This may reflect the similarity in content for this topic, including the diagrams found in the textbooks which are used. It appears that students in all four study samples do not understand the exaggerations or appreciate the conventions associated with diagrams which appear in chemistry textbooks. Chi square analysis of the six items response patterns revealed that small, but statistically significant differences between cultures (p<.001) existed for all questions. It seems likely that students respond to diagrams in much the same way irrespective of cultural setting, and that such differences are due to the way the topic, the kinetic theory of matter, is treated in the four countries. This is consistent with the findings of other cross-cultural studies within the constructivist framework (Driver, 1989).

Of the five test items concerned with 'exaggerations' the majority of students responded as if they accepted the diagrams at face value. The high percentage of responses consistent with textbooks across all four study samples would suggest that students operate at a surface level and consider 'exaggerated forms' as accurately portraying actual situations. That is, they fail to process at a deeper level which distinguishes between pictorial and scientific dimensions of a diagram.

While convention 4 (Particle size remains constant irrespective of state) is taught in all four countries studied, a significant percentage of students (13% in Malaysia, 35% in
<table>
<thead>
<tr>
<th>Question</th>
<th>Responses by alternative selected</th>
<th></th>
<th>( x^2 )</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Australia 1 2 3 4 5</td>
<td>Canada 1 2 3 4 5</td>
<td>Malaysia 1 2 3 4 5</td>
<td>Nigeria 1 2 3 4 5</td>
</tr>
<tr>
<td>1</td>
<td>46 25 29 0 -</td>
<td>23 37 39 1 -</td>
<td>16 43 41 0 -</td>
<td>13 35 52 0 -</td>
</tr>
<tr>
<td>2</td>
<td>25 53 15 7 -</td>
<td>20 62 16 2 -</td>
<td>12 82 6 0 -</td>
<td>9 78 15 7 -</td>
</tr>
<tr>
<td>3</td>
<td>46 14 14 25 1</td>
<td>29 19 27 23 2</td>
<td>30 24 24 22 0</td>
<td>36 17 33 1 3</td>
</tr>
<tr>
<td>4</td>
<td>7 58 29 6 -</td>
<td>12 23 55 10 -</td>
<td>8 5 87 0 -</td>
<td>39 29 28 4 -</td>
</tr>
<tr>
<td>5</td>
<td>39 39 9 10 3</td>
<td>58 16 6 16 4</td>
<td>51 18 8 23 0</td>
<td>12 13 4 64 7</td>
</tr>
<tr>
<td>6</td>
<td>10 53 37 -</td>
<td>12 29 59 -</td>
<td>7 23 70 -</td>
<td>3 65 32 -</td>
</tr>
</tbody>
</table>

Note: The entry for the last alternative indicates the number of non responses.

Canada, 65% in Nigeria and 65% in Australia) hold contrary views. Explanations offered by these students reveal considerable confusion and misunderstandings. Students appeared to confuse particle size with the volume the molecule effectively occupies with increased kinetic energy. Those who offered an explanation for selecting alternative (1) frequently stated that molecules in solids were large, molecules in liquids somewhat smaller and gas molecules were very small. It may well be that such ‘misunderstandings’ were gained from the way molecules are represented in textbook diagrams. On the other hand some students interpreted the question in terms of what they had learned about paraffins and the effect of molecular weight on melting point and boiling point.

Question 6, which required students to actually represent a solution, was less frequently answered and proved much more difficult than earlier questions which simply asked for a choice between alternative diagrams. Some students commented on the difficulty level of this question - they were not used to creating diagrams to illustrate particular situations.

It is common for publishers in the United Kingdom to have branches in former British colonies and for them to distribute the same science materials or to develop local versions. This is one of the reasons why programs such as Nuffield Science have often provided a common reference point for teachers and students in the countries involved in this study. The curriculum content of science programs tend to be very similar and it is likely that students would have been exposed to the same kinds of diagrams in relation to the particular nature of matter. Students would thus know that when solids, such as lead, melt, the immediate volume change is several percent but when liquids, such as water, boil at atmospheric pressure, the immediate volume increases in the order of 1000-fold and that for dilute aqueous solution the molarity of water is approximately 55 mol l-1.

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An Invitation to Boston to participate in the National Convention of NSTA

March 26-29, 1992

Each year, the International Committee of the National Science Teachers Association, USA hosts an "International Round Table".

At this 90 minute session, presenters from different parts of the world discuss their nation's educational programs. Each presenter has a table for materials, and participants select those countries they wish to learn about.

If you would like an official invitation to participate as a representative of your country, write to:

John E Penick  
Science Education Center  
Room 789 VAN  
University of Iowa  
Iowa City IA 52242  
USA

Unfortunately, you will have to arrange your own funding; but a letter of invitation and your name in the program may help you in that quest.
Conclusion
Given that diagrams are an integral part of many science lessons, the results of the study suggest that teachers should strongly discourage the blind acceptance of chemistry diagrams by their students. Teachers should be aware of the epistemological features of scientific diagrams in order to convey to students the richness inherent in such illustrations. Students should view all diagrams critically and be readily able to distinguish between the diagram as a representative 'pictorial model' and the scientific component or idea portrayed. As a first step towards a greater awareness and appreciation of the nature and role of scientific diagrams, students should be given opportunities to actively engage in drawing diagrams. The active construction of diagrams by the students themselves has the potential of becoming a powerful learning tool in science by developing the intentions of the illustrator and the inherent limitations associated with scientific diagrams (Lowe, 1989). Engaging students in constructing and then discussing their various representations of the same concept or situation would serve to highlight the problems associated with a single representation and encourage them to look beyond surface features.

References
Lowe, R K (1989) Scientific diagrams: How well can students read them Curtin University Key Paper No. 3 Centre for School Science and Mathematics, Perth
Wheatley, G H (1991) Constructivist perspectives on science and mathematics learning Science Education 75 (1), 9-12

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INCOTE 92
International Conference on Technology Education
Weimar, Germany

This symposium will be the first pan-European meeting on technology education to be held in Germany. The principal aim of the symposium, which is being organised in collaboration with a number of organisations including ICASE and INISTE, will be to discuss technological literacy and competence in technology education within a European dimension. The majority of participants will be from European countries, with a few key people from other regions of the world. The principal language of the symposium will be English.

For further information, contact:
Dr D Blandow, INCOTE 92
Pädagogische Hochschule
Nordhäuserstraße 63, 0-5063 Erfurt, Germany
The Future Direction of Sustainable Development in the Curriculum

Summary Report of the World '90 Preconference, Canada

by Dennis Chisman, Jack Holbrook & Cele de Var

Introduction

This report is a document for action! It is based on papers and discussions presented at a workshop in Winnipeg, Manitoba to examine the future directions of sustainable development in the curriculum. It was held immediately prior to the major international conference World '90 - World Environment, Energy and Economic Conference, 17-20 October 1990, also in Winnipeg.

The small meeting of 40-50 specifically invited participants from across Canada and from overseas was held at the St Benedict's Education Centre, Winnipeg, from 14-17 October 1990. It was organised by the Science Teachers' Association of Manitoba (STAM), the Canadian Association for Science Education (CASE) and the Manitoba Education and Training Department of the Government of Manitoba, with support from UNESCO and the International Council of Associations for Science Education (ICASE).

The full report with plenary papers, the opening address by Mr Len Derka, Provincial Minister for Education in Manitoba, discussion group reports and a list of participants, is available as a supplement to this Summary Report. The full report also contains some of the curriculum models presented at the workshop.

The Background

The background to the meeting can be traced to a general appreciation, especially in Canada, that the future of the human species depends on a recognition that natural resources are finite and on a recognition that the continuation of the human race will depend on the willingness and ability of humans to abstain from destroying the natural systems that regenerate the world as we know it.

Appreciation for a livable global environment being dependent on sustainable development of the entire human family, is described in more detail in the report of the World Commission on Environment and Development, 1987 Our Common Future - known as the Brundtland Report, after the Chairman, Gro. Harlem Brundtland, the then Prime Minister of Norway. Sustainable Development, in that report, is defined as:

'Development that meets the needs of the present without compromising the ability of future generations to meet their own needs'.

The overall objective of the meeting was the interpretation of this understanding of sustainable development in an educational context, leading to a model of how sustainable development concepts can be integrated into the curriculum.

The participants in the meeting endeavoured, therefore, to identify sustainable development education and illustrate how it might be incorporated into the curriculum at various levels, and to identify teaching strategies, teaching methods and resources which would be required to implement such strategies.

The Need for Change

The need for change, from an educational point of view, is based on the overall desire to develop an educational literate society in which sustainable development is understood and appreciated within the context of environmental, economic and energy strategies thus promoting the sharing of a better quality of life, now and for future generations. This need is in harmony with the declared aims of UNESCO for scientific and technological literacy for all worldwide, alongside universal literacy and numeracy.

Environmental concerns have risen, peaked, and declined in the past, with little fundamental change in human behaviour. Some environmentalists maintain that clean-up campaigns to address local pollution problems are merely cosmetic approaches to a disease which has deeper causes. If we take the scientific findings concerning global environmental changes seriously, then they indicate the need for a much higher level of public awareness and greater commitment to personal and community action. As major agencies of education and socialisation, schools can plan an important role in developing citizens who are environmentally informed and aware. But before programs can be designed or implemented effectively, we need to develop a clear understanding of the elements of environmental literacy.

In many countries, curricula changes are moving towards the integration of science and technology education with societal issues and values - the Science Technology and Society (STS) movement. The emphasis in many science courses is thus moving towards an appreciation of the quality of life and the relevance of science in society and in meeting the issues facing a society. But this trend, which should permeate formal and non-formal education systems, requires much greater support and understanding from Governments, parents, and even teachers and students for it to succeed. The need is urgent and the inclusion of sustainable development education, through environmental education, energy education, health education and an understanding of economic development, is essential.

This change requires more than a change of syllabus content and knowledge and more than a change in understanding and process skills. It requires strategies to bring about a major change of attitudes and societal expectations of the role of schools in values education.

The need for change is urgent. The problems will not go away; and education, in its widest sense, is the only hope we
have to ensure that our fragile environment is cared for.

**The Obstacles to Change**

Change is expensive. Change is disruptive of habits and values held by parents and students. Change affects the morale of teachers if handled badly. The attitude of many individuals to the need for change, which is unfortunately reflected by decision-makers, administrators and policy-makers in education, including politicians at the highest levels of Government may be summarised by one or more of the following:

- Since we do not know all there is to know, let us wait to act in case we may not have to act at all;
- Because there is no historical precedent for what is happening we refuse to believe it is happening (this is the 'there is nothing new under the sun' syndrome);
- It will be easier to adapt than try to change (this is the 'we will evolve out of the problem' syndrome);
- Lack of widespread awareness among the general public and among political leaders;
- Because the problems are so severe, their solutions will be difficult - very difficult (the 'we may fail, so why try?' syndrome).

**The Power of Education to Bring About Change**

Education is the central theme in our lives. It prepares the young generation for the life that lies ahead, and it informs adults of the world about them.

The transformation in what we teach, how we teach it and the manner in which it is assessed will be crucial to the major knowledge and attitude changes which are essential if we are to introduce aspects of sustainable development into the curriculum and prepare students to give greater consideration to values and ethics. This transformation and progression will involve consultations and agreements and needs the active involvement of those concerned at every level, right up to the senior levels in government.

The power of education can only be harnessed by involving all the key figures and organisations in the developmental and decision-making process, perhaps through the establishment of educational task forces, thus including teachers, curriculum developers and advisers, outside agencies that can provide the link between school and the community, as well as Ministry of Education officials, and employers.

**Educational Strategies for Change**

(1) The overall strategy

This is to design courses so as to prepare for a 'sustainable development' literate society. To this end three important criteria for curriculum change are:

- relevance
- practicality
- values driven

**Relevance** implies the use of community resources and the incorporation of local issues and practices into the curriculum.

**Practicality** means activity-based learning (doing and action), with the inclusion of gaining balanced points of view and training in the recognition of bias.

**Values** involve cultural issues, personal interdependence and informed judgements both from a holistic view of the world and from a local society perspective.

(2) Major issues.

These include, for example:

- population control and support
- poverty eradication and avoidance
- intercultural tolerance
- self-sufficiency and quality of life
- global economics: needs not greed
- transfer of appropriate technology
- environmental literacy

(3) Curriculum models for sustainable development

These should be based on the interrelation of knowledge, skills and values.

**Values**, the pinnacle of the triangle, places emphasis on a respect for life, the quality of personal life, aesthetics in nature, ethical issues and cultural and societal priorities. The development of such values should be seen as a priority goal for education.

**Knowledge** embraces the factual part of the curriculum and covers, on a need to know basis, the scientific, cultural, economic, social and environmental data and structure plus

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the interconnection of systems, methods of enhancing scientific and technological processes and the management of risk.

Skills includes the variety of scientific methods and particularly decision-making, problem solving and communication skills.

The development and success of any curriculum model depends, for both formal and non-formal types of courses, on four important components, namely curriculum development; assessment strategies; resources available; and the implementation strategy.

The curriculum to be developed needs to emphasise values education, incorporating on a need to know basis, knowledge, conceptual learning and skills.

The assessment needs to measure the values and skills alongside factual knowledge and put emphasis on the societal learning.

Resources are needed to support the teaching of such a new curriculum. For example, case studies would require visual aids and experimental support materials.

The implementation is a crucial factor and in particular an emphasis is required on the need for pre- and in-service teacher support which highlight community needs and the local situation.

Areas of study can be illustrated in another model emphasising interconnections and showing that sustainable development is not confined to any one subject area.

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**THE BRITISH COUNCIL**

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**on**

**Chemistry and Physics Education**

University of Dortmund
Germany

**June 10-12, 1992**

Contact:

Prof Dr Hans-Jürgen Schmidt
University of Dortmund
Department of Chemistry
Otto-Hahn-Straße
4600 Dortmund 50
Germany
• An understanding that we need to survive and improve our quality of life, but at the same time, be caring of other species that make up the fauna and flora of our planet;
• An understanding of global perspectives.

Important components of an environmental education program that incorporated sustainable development goals are seen as the ability to:
• Think ahead, to predict (forecast) and to plan;
• Consider value issues from different perspectives and make informed decisions;
• Distinguish between facts, conjecture (hypotheses), proven theories (scientific laws) and values;
• Go beyond awareness and knowledge, to suggestions for action based on balanced judgement;
• Understand a set of basic concepts and facts, for example ecosystems, and acquire new concepts;
• Work cooperatively with others and be sensitive to the views of others;
• Develop and use skills in the processes of knowing, enquiring, acting, judging, opening, imagining, connecting and making value judgements;
• Distinguish between the maps and representations of nature we receive from the media (TV and newspapers), and recognise that the real world may be quite different when personally experienced. (Seeing pictures of beautiful wildlife on TV may not be the same as our reaction when standing a few metres away from a bulging bull elk!)

Topics in a program of environmental education would need to address population and food supply; environmental deprivation through greenhouse effect, ozone layer, deforestation, soil erosion, acid rain, air, water and land pollution, species depletion, the finiteness of resources (energy conservation), maintenance of health (work and leisure), measures to balance technological advancement with environmental conservation, and the interpretations of thinking globally.

Sustainability as a concept in this context was examined in the workshop. One view was that sustainability should be regarded as a tripod of ideas:
(1) The human species is part of nature. Its existence depends on its ability to draw sustenance from a FINITE natural world; its continuance depends on its ability to abstain from destroying the natural systems that regenerate the world.
(2) Economic activity must account for the environmental costs of production. The 'wealth' we create today is stolen from our descendants.
(3) The maintenance of a livable global environment depends on the sustainable development of the entire human family.

The Proposed Changes

The proposed changes would imply changes in teacher education, changes to the educational system and its organisation, and changes in course content.

Teacher education needs to include techniques whereby teachers are able to function without textbooks and be able to design teaching materials that can emphasise the affective domain, plus the decision-making and problem solving skills. It would also have to prepare teachers more adequately to teach sensitive issues, including bias and conflict.

The changes to the Educational System and its Organisation need to include greater flexibility with greater attention to education and less to bureaucratic expediency. Flexibility is needed in areas such as timetabling - to allow for fieldwork and field trips; additional preparation time for teachers for activity-oriented work and the changing society; support materials and support technology to keep pace with the learning expectations of the young, inculcated by society; and acceptance of teachers' ability and need to deal with controversy and bias based on value judgements.

The content would be less factual and more attention given to developing skills, particularly in the areas of communication, problem recognition and solving, and informed, balanced decision-making.

Such changes imply changes in assessment strategies so that values education is given more prominence and skills such as problem solving and decision-making emphasised.

The Role of Educators

The implementation of the proposals to establish curriculum models incorporating sustainable development in courses such as environmental education will require the active involvement of educators.

Educators will be required to design and organise programs and the accompanying pre- and in-service courses for teachers, to select appropriate topics for the new syllabuses on which to build the skills and values related to sustainable developmental thinking, to review resources from the community and elsewhere for such teaching, to involve the local communities in understanding and supporting such change and generally to develop implementational strategies.

The role of the teacher will inevitably have to change. They will become more involved in facilitating changes of attitudes and guiding students to gain values rather than merely teaching factual knowledge. Much is already happening in some countries - at the grassroots level. An appreciation of sustainability is already evident as shown for example by the seminar examples in the World '90 conference given by teachers on recycling in elementary schools. Teachers need to coordinate with other teachers across nations and across continents. To aid this, science teacher associations have formed links through an international umbrella - the International Council of Associations for Science Education (ICASE).

Systems in countries around the world do differ. Changes need to be considered in the national or logical context. Teachers will have to be trained to manage such change; and ensure that improvements will follow from change, and that equity prevails. They will have to be involved at the political, social and economic levels. The benefits can be for everyone, throughout the world. But teachers will need help, encouragement and recognition to undertake these new roles. Time is pressing. Sustainable development in the curriculum is an urgent need.
An Introductory Look at Curricula and Examinations Worldwide

Part 2

by Dr Jack B Holbrook
Executive Secretary, ICASE

This article is an extract from a report by the same title, prepared by ICASE in fulfillment of a contract with the Science and Technology Section, Division of Educational Development, Unesco. Part 1, published in the September 91 issue Vol 2 No 3, dealt with worldwide trends. Part 2 features comments on specific countries in Africa, Asia, Australasia, Caribbean, Europe and North America.

AFRICA

1. Botswana

The Integrated Science curriculum for grade 8 and 9 is a junior secondary examination syllabus first introduced in 1987. The syllabus is based on academic science although societal topics are included. The examination seems to be knowledge and science skills orientated and thus aimed at providing an assessment of the base from which further science can continue.

2. Ghana

The Science syllabuses for grade 7-8 and 10-12 were produced by the Ministry of Education in 1990. These teaching syllabuses seem vague but the grade 7 and 8 syllabus includes some societal points. The grade 10-12 syllabus is academic in nature.

3. Lesotho

The course for grade 9-12 is externally assessed. There is no assessment by teachers, but this is not seen as being particularly necessary. More worrying is that the lack of assessment of practical work is accepted as appropriate with the reason given that it is difficult to maintain security. No mention is made concerning the lack of interest in assessment of experimental work by the teacher, but one suspects the competitive system brings concerns on reliability of such a system.

4. Nigeria

The grade 7-9 syllabus, introduced in 1985, refers to Integrated Science, whereas the grade 10-12 syllabuses cover Biology, Astronomy, Physics and Chemistry as separate courses. All are teaching syllabuses with aims and objectives given. The approach is basically through science concepts, although the integrated science course uses thematic headings and brings in some societal factors following the conceptual introduction.

5. Sierra Leone

The 1990 grade 7-9 draft teaching syllabus was produced by the Institute of Education and called Integrated Science. It is based on themes but, as a whole, the course is driven by fundamental science concepts.

6. Swaziland

The curriculum at grade 11-12 level is externally assessed. This is seen as being both valid and reliable although there is some concern that the examination questions should have more local relevance. Practical skills are not assessed at this level, but its appropriateness is not questioned. The impression given is of an academic course, organised around the dominating external examinations.

7. Zambia

Both an Environmental Science and an Agricultural Science syllabus for the junior secondary level, produced in 1983, were mainly traditional science introduced by topics. Project work in Agricultural Science was specifically encouraged and was awarded 20% of marks. The use of project work as a means of assessment is now discontinued because of poor reliability.

8. Zimbabwe

The 1989 grade 7-9 science syllabus and the 1991 0-level syllabus in science were developed using themes but again relied upon fundamental science concepts for sequencing. Little help was given to the teacher in these examination syllabuses.

ASIA

1. Bahrain

Syllabuses at the junior secondary level are separated into Chemistry, Physics and Biology. The latest, introduced in 1987, are organised by concepts and are thus typically academic. Little support is provided for the teacher.

2. Bangladesh

The curriculum for grade 9-10 is factual and academic. There is no teacher assessment. The assessment is seen as not valid nor reliable as it encourages little more that rote learning. Practical work is assessed, but this is not seen as being particularly valid.

3. Bhutan

Syllabuses were available for grade VII to X. These 1989 syllabuses which were based solely on the prescribed textbooks, were concept oriented and very much seen as providing a science base for later studies. Little help was given to the teacher, and the examination is very much knowledge based.
4. India

A syllabus book, covering all courses at grade IX and X levels, was produced by NCERT in 1988. Although organised through science concepts, the unit headings are thematic and include areas such as ‘world of work’. As well as the science course, students undertake a course called work experience in which many societal aspects are met; unfortunately little link was apparent between the two syllabuses. A trend from the questionnaire was that examination questions were becoming more objective and geared to academic science. This seems to differ from the trend in other countries where more open ended questions are being developed. Practical work is assessed through project work and by a teacher based examination, but there seems to be little trend towards continuous assessment.

5. Jordan

Very traditional syllabuses in Physics, Chemistry and Biology, developed by the Ministry of Education for levels Secondary 1 and 2, are geared to the textbook. The English translations of the syllabuses were textbook extracts which offered little help to the teacher. Examination papers were available in Arabic.

6. Korea

An English translation of the science syllabus for grade 7-9 and separate science syllabuses for grade 10-12 in Physics, Chemistry, Biology and Earth Science, was available. These teaching syllabuses, produced by the Korean Educational Development Institute in 1984, are based on a science concept approach and depict academic science courses.

7. Pakistan

It appears that the curriculum in operation in Pakistan has an academic approach, factually and concept oriented with little societal emphasis. No assessment by the teacher takes place at the grade 9-10 secondary levels, but there is assessment of practical skills (25%) which is seen as valid to some extent.

8. Philippines

The curriculum at grade 10-11 level in the Philippines is part of tertiary level education. This frees the course from external examination pressures and teachers are able to assess students on a variety of scientific skills such as experimental work, project work and attitudes. Nevertheless, the validity and reliability of this is questioned as the system is informal and little link is undertaken between institutions.

AUSTRALASIA

1. Fiji

Senior secondary examination syllabuses in the separate sciences are academic in approach and concept driven. Examination papers stress knowledge.

2. New Zealand

A very different approach to syllabus development applies to grade 7-11 science. The 1989 science syllabus produced by the Department of Education, provides extensive guidelines for the teacher including a grid of skills against context, but not a prescribed content. Teachers are encouraged to produce their own schemes of work based on local interests and conditions. The syllabus stresses ‘science for all’ and that science should be relevant to the society in which students live. The separate science syllabuses for grade 12 and 13 produced in 1990, contrasted greatly with the grade 7-11 syllabus and followed a traditional conceptual approach; units are based on concepts. As these were examination syllabuses, it was seen that there was a need to determine how far students had gained a basis in science concepts before continuing further in the subject.

CARIBBEAN

1. Barbados

Examination syllabuses at the grade 10-11 levels in Integrated Science (single and double awards), Chemistry, Physics, Biology and Agricultural Science (double award) were produced between 1985 and 1989. They are based on themes or topics. Examination papers stress knowledge; assessment of practical work is carried out on an internal basis. The syllabuses stress fundamental science concepts.

2. Trinidad

The syllabus governing the teaching at grade 10-11 level is the examination syllabus, and is seen as too factual and too long. Teacher assessment contributes 20-30% and includes experimental work, course content and attitudes. This is seen as both valid and reliable. There is some concern as to whether moving to a 100% teacher assessment would be more appropriate as two systems, internal and external, seem a duplication of effort.

EUROPE

1. Iceland

The grade 8-10 science teaching syllabus, produced by the Ministry of Education in 1989, has a considerable emphasis on values. Teachers can select topics and can provide additional experiences for students. Environmental education is incorporated in a whole school policy. The syllabuses for grade 11-14 are in the separate sciences. These are organised by concepts but do provide for students to complete different levels of science within each discipline. These courses tend to be traditional and stress science for continuation. As such, there is little emphasis on societal aspects of science.

2. Ireland

The junior secondary teaching syllabus for age 12-15, produced by the Department of Education in 1989, was organised about topics and conceptual units, and allowed for core and extension material. Local studies contributed 40% of the examination, and a variety of assessment methods were advocated.

3. Malta

Chemistry and Physics teaching syllabuses for Form 4 and 5 are academic and based on textbooks. An integrated science syllabus for grade 9 has topic headings for each unit; it appears that the course is very prescriptive and concept driven.

4. Spain

At the grade 11-13 level, assessment by the teacher accounts for 30-40% of the marks. This is not seen as valid
Science and Technology Education Activities in Asia and the Pacific

by Lucille Gregorio, Unesco PROAP, Thailand

In accordance with UNESCO's Program in Science and Technology Education, and the 1991 Schedule of Activities of the Asia and Pacific Program of Educational Innovation for Development (APEID), UNESCO-PROAP organised two regional workshops, one in Shanghai, China and the other in Penang, Malaysia.

Regional Workshop on Nurturing and Identifying Talents in Science, Technology and Mathematics

The meeting, held from 16-27 September 1991 at Shanghai Normal University, was organised by the Shanghai Institute of Educational Research.

The objectives of the workshop, with reference to science, technology and mathematics were:

1. to promote exchange of experiences/ideas and collectively develop guidelines/strategies for nurturing and identifying talents;
2. to cooperatively develop guidelines and instruments in preparing curricular programs for nurturing, identifying talents; and
3. to identify competencies required of teachers so as to enable them to nurture, and identify talents from amongst the learners.

Participants at the meeting were invited from the following Member States of UNESCO: Australia, Bangladesh, China, India, Indonesia, Iran, Japan, Malaysia, Myanmar, New Zealand, Pakistan, Philippines, Republic of Korea, Sri Lanka, Thailand, USSR and Vietnam.

The topics discussed in the workshop were focussed on the current situation in nurturing and identifying talents in science, technology and mathematics in the participant's country; the curriculum strategies practised in the initial development of creativity, problem solving and critical thinking skills; criteria in identifying the talented amongst the learners; abilities to be further developed by the identified talents and the curriculum strategies proposed for further nurturing of the talents; competencies required by teachers so as to enable them to nurture, identify and further nurture talents; and recommendations for follow-up actions at country/school levels.

Regional Experts' Workshop on Development of Strategies and Methods for Teaching Values in the Context of Science and Technology

The workshop was organised by SEAMEO-RECSAM, Penang, Malaysia from 18-29 November 1991. The workshop, with reference to science and technology education at the primary and secondary levels, developed training materials on the teaching of ethics and values.

The participants invited were from Australia, Bhutan, China, India, Indonesia, Iran, Japan, Malaysia, Maldives, Nepal, New Zealand, Philippines, Thailand, USSR and Vietnam.

The discussion at the workshop in the context of science and technology education at primary/secondary level was focussed on: the objectives and contents of values/ethics education; strategies for learning/teaching of values/ethics; methods of evaluation of learning of values/ethics; development of sample lessons; and the description of the developmental process (planning to implementation) involved including training of teachers in learning and teaching of values and ethics.
Education in Global Change

Moving Scientific Research Into the Classroom

A study in global change - the International Geosphere-Biosphere Program - has inspired the Committee on Teaching of Science (CTS) of the International Council of Scientific Unions (ICSU) to initiate a major curriculum development project, called Education in Global Change.

The IGBP is carrying out scientific research that is of immediate interest to young people, and it was judged feasible by CTS to produce related teaching materials about global change at all levels, from elementary through postgraduate. CTS has targeted its initial curriculum project in global change at 16-19 year old science students. The project uses global change issues to introduce and illustrate scientific principles. In this endeavour, CTS has sought active help from scientists involved in global change research.

The CTS believes it is of crucial importance to attract more young people into the science professions, countering the current downturn in students entering the sciences. Young people must come to understand the role of science within society and how scientists are able to provide the information needed for the solutions of both natural and human induced problems facing societies and the concomitant political, social economic, and technological issues.

Often, the research issues that are currently facing the scientific community are ignored by science teachers in schools and colleges. There are several reasons for this: the concepts are very difficult; teachers do not have enough information; and there is not enough time in the syllabus. Young people may pick up information from the media, but it often is only a superficial coverage. Thus, many young people find out neither about the scientific issues, nor the scientists who might inspire them to choose science as a possible career.

By bringing together scientists and science educators, the CTS is providing teaching materials for schools and colleges that illustrate the essential role of the scientist in society. The materials also offer authoritative information on important scientific principles. They demonstrate that the science being used to study global change has no national boundaries.

The materials are designed to be easy for teachers to use. They are interactive and encourage the participation of students, requiring practical work, discussion, data collection, and data interpretation. Suggestions to the teacher include advice on easy ways to adapt and extend the materials to meet local conditions.

It is planned that the final, printed materials will be in the form of inexpensive booklets. Teachers using the materials with students can readily copy (copyright waived) the sets they require. To implement the materials, a school or college need only obtain one copy of each booklet.

The CTS held writing workshops in June 1990 at the University of California, Berkeley and in May 1991 at York University, UK. Drafts of seven units have been produced: The Global Carbon Cycle; Remote Sensing: Window on Global Change; The Changing Atmosphere; Clues from the Past: Glimpses of Our Future; Land and Sea Effects on Global Change; Energy Cycles; and the Stratosphere. The units are edited by teams of scientists and science educators based in the United Kingdom, United States, France and India. During its various stages, the project has been co-directed by D J Waddington, M H Gardner, and J P Stoltman.

There are several important ways in which the scientific community can contribute to the ICSU CTS initiative: by reviewing units, helping to plan implementation of units, and suggesting topics. As part of the development process the units are being tried out in schools and contacts with teachers are important. The Committee would like further opportunities to visit scientists working directly in the fields in which it is producing teaching materials.

If you are interested in receiving more information about this project, please contact:

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or

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Kalamazoo, MI 49008-5053
USA

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19
Report on the Meeting of the ICSU Committee on the Teaching of Science May 1-2 in Paris

by Joseph P Stolman, Secretary ICSU-CTS

The International Council of Scientific Unions (ICSU) Committee on the Teaching of Science (CTS) held its meeting in Paris at ICSU headquarters on May 1 and 2, 1991. Officers of CTS, representatives from the Scientific Union members of CTS, affiliate representatives from COSTED and ICASE, and observers from UNESCO, ICSU, IUIS, and URSI attended the meeting. CTS meets every two years in order to review policies, programs, and projects in science education internationally, and to develop and discuss plans for future initiatives.

Professor D Waddington welcomed the large number of colleagues attending, and made introductions of CTS representatives and observers. The death of Professor M Gardner, USA, was announced, and a moment of silence was held in her memory. Two members of CTS, Professors Chandrasek, India, and L Tan, Singapore, are ending their terms as officers and were thanked by the Chairman for their years of service to the Committee.

Reports on the various activities of CTS that have been underway the past two years were presented. These included the Education in Global Change Project, the Harare Generator, the Informatics and Microcomputer Publication, the Inexpensive Equipment Project, the University Science Teaching Project, the Subcommittee for Elementary Science, and the Ethical Issues in Teaching Science Workshop. The reports on the Education in Global Change Project and the Harare Generator represented the major commitments of resources by CTS during the past two years.

D Waddington reported on the Education in Global Change Project (see report in this section).

J Stolman reported on the Harare Generator held at the University of Zimbabwe in January 1991. The Generator was designed to bring African teachers together with experts in curriculum design and materials production in order to write curriculum materials that were appropriate for teaching science in African schools. There were 106 participants, with 55 of them coming from Zimbabwe. The others were scientists, teachers, and science educators from other African countries and guests from outside of Africa.

Of the other projects, a draft of an informatics and microcomputer manuscript has been distributed for review by science educators and scientists. There is interest in continuing the work on inexpensive equipment development, especially for laboratory instruction in the developing countries. CTS will complete a sample survey to assess the availability of information regarding inexpensive equipment from different scientific unions and organisations. The University Science Teaching Project has completed its first phase and newly designed curriculum materials are being produced for use in Thailand in chemistry, biology, and physics. The next phase of the project is being discussed by the principal investigators and the funding agencies, and there is interest in carrying the project to a regional level through workshops and dissemination of products. The Subcommittee on Elementary Science will have a two volume series reporting their recommendations on the preparation of future elementary science and mathematics teachers published by UNESCO in 1991.

During 1991 an ICSU appointed Ad Hoc Committee on ICSU Science/Teaching Education Activity met and prepared a report, with input from the ICSU-CTS Chairman and Secretary, which has been forwarded to the ICSU Executive for consideration. The Ad Hoc Committee Report calls for a restructuring of CTS membership, providing a stronger financial support base, and for aligning initiatives by CTS to broad scientific education policy goals internationally.

During the CTS meeting, copies of the report were distributed to representatives for their review and discussion. In general, the report was accepted by the CTS representatives as positive. However, the discussion did result in several recommendations to the report that have been submitted to the ICSU Executive.

Reports of the activities of the Education Commissions of the Scientific Unions were both submitted in writing and distributed as well as commented upon by representatives. The reports revealed a number of significant educational activities that are being carried out by the Unions. They also reinforced the important role of CTS in coordinating and facilitating interdisciplinary initiatives in science education.

New initiatives by CTS were discussed at length. They include:
- Leadership workshops for implementing the Education in Global Change classroom materials in South Asia, Francophone Africa, and Latin America.
- The education in Natural Disasters Reduction Project being undertaken to produce an international handbook for teachers on natural disasters reduction through science education.
- Co-sponsorship with ICASE and several other organisations of the Space Science Project for Teachers of Science in conjunction with the International Space Year.
- Co-sponsorship with ICASE of the UNESCO Conference on Science Education for All in 1993.

The next meeting of the full body of ICSU-CTS is scheduled for 1993. For information about ICSU-CTS, please write to:

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York Y01 5DD, UK
Professor J Stolman
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Kalamazoo, Michigan 49008-5053
USA
teaching; Dr Zöchling, Berndorf, Austria, on Environmental measurements at cross roads; J Holman, Watford, UK, on the British approach to environmental education and the SATIS Project; J P Simon, Brussels, Belgium, on Retraining science teachers for teaching ecology; and Prof Ciesielska, Krakow, on Teacher education in the field of ecology.

There were also eight workshops on the theme of environmental education. The European Representative of ICASE addressed the general assembly on possible activities by science teacher associations; and contributed to a workshop on chemistry education and the environment.

Sixty five participants attended the Conference including three from Belgium, two from The Netherlands, one from Austria, and one from the UK.

The Conference has provided an excellent start to the programs of SNPPiT - the first science teachers association in Eastern Europe to become a member of ICASE.

For further information about the Conference, or about SNPPiT, write to:

Alicja Wojtyna-Jodko
President, SNPPiT
Skrytky Pocztowa 62
85791 Bydgoszcz 32
Poland

AISTA - All India Science Teachers Association

The proposal to form an Association of science teachers from all over India originated at the All India Seminar on the Teaching of Science in Secondary Schools held in June 1956. Contacts made at this event and the work accomplished there proved so stimulating that participants decided to set up a permanent organisation - thus the All India Science Teachers Association was born. The Association's activities are wholly devoted towards the promotion of science education and are recognised by the National Council of Educational Research and Training and other organisations.

The Association holds a three-day conference each year, usually towards the end of December, in different cities of the country. The program includes lectures, demonstrations, discussions, excursions to places of scientific interest, and exhibitions. The Krishnan Memorial Lecture and the Joshi Memorial Lecture are delivered by distinguished scientists and educationists each year. Teaching and science films are also screened.

Regional activities are organised by branches - some state branches organise state level conferences, lecture demonstration series, science quiz contests, science fairs, science aptitude and talent tests. Some local branches have been preparing science films and other aids related to scientific topics.

The Association is participating in an International Study on Science Education. The Association is a founder member of ICASE and participates in its activities. The Association's President, Shri B G Pitre, was the Chairman of ICASE for the term 1976-79.

The Association operates through an Executive Council on which each state and branch association with a membership of more than 50 is represented.

The Vigyan Shikshak, first published in March 1957, is the official journal of the Association. It is a quarterly journal with a nationwide circulation, and contains articles, teaching units and information on a wide spectrum of scientific and educational topics relevant to primary and secondary teaching. There are also film and book reviews, diagrams and notes on improvised apparatus, and original experiments on all branches of science teaching.

The Association has recently undertaken the publication of a series of background readers for pupils on a variety of subjects, and a guide book on science club activities and topics.

For further information about AISTA, contact:

Mr R K Mohra, HQ Secretary,
AISTA, Sardar Patel Vidyalaya, Lodhi Estate, New Delhi 110003, India.
Update: Project 2061
by Dr Kenneth Russell Roy
ICASE North American Representative

Project 2061 is a three phase initiative to provide direction for the restructuring of science education in the United States. In actuality, the American Association for the Advancement of Science under the leadership of Dr F James Rutherford, Director, has focussed on an interdisciplinary approach with touchstones to mathematics, technology education, social sciences and others. The project's main mission is to provide science for all Americans.

At present, Phase II is in operation and addresses the task of developing alternative curriculum models and Blueprints for Action. Phase I involved the development of exit outcomes resulting from twelve years of education. The models to effect these outcomes are being prepared by teams of educators in six school districts around the country. Blueprints for Action will address other aspects of the education matrix needed to restructure the present framework to allow the new models to work.

Issues to be addressed in the Blueprints for Action will include the following major areas:

1. **Teacher Education**
   Needs in preservice and inservice training to produce teachers who will understand Project 2061 ideas and become effective change agents.

2. **Materials and Technology**
   Development and evaluation of instructional materials and technology which are not available presently in many areas.

3. **Assessment**
   All facets on assessment will be addressed from in-class assessment during instruction, school program evaluation, to general monitoring of educational progress at state and national levels.

4. **Research**
   In order for models to be developed and to evolve, more research on learning to learn through thinking skills will be addressed. Also, the myriad of present research needs to be considered for practitioners.

5. **Curriculum Connections**
   Given that the project touches on many disciplines, attention must be given to scheduling models, achievement ability grouping issues and other levelling phenomena.

6. **School Organisation**
   Alternatives for the general philosophy and organisation of school structures may also be addressed.

7. **Parents and Community**
   Key to restructuring is the support and involvement of parents and the business community. The Blueprint for Action will address how these groups can be effective.

8. **Equity**
   Given that the mission statement of 2061 is "Science for all Americans", new areas need to be explored to address equity issues relative to minorities, females, the poor and other at-risk populations.

9. **Higher Education**
   Key to the restructuring is the articulation with higher education. Specifically issues dealing with the credit for course work, admission requirements and more.

According to Dr Rutherford, the curriculum teams have been working during the past two years on what they believe students should have achieved by grades 2, 5, 8 and 12. A 1992 timeline is in place to publish the final consensus for national norms and indication of progress.

The Project will take over 20 years to effect change. It is one of several major reform movements in the USA at present.

Many additional programs have been initiated at the state levels such as the California Science Framework and the Kentucky Ky Aces program. Another major national program of significance is the National Science Teachers Association's Scope, Sequence, and Coordination Project. All of these programs are being developed to prepare US students in science for the 21st Century.

For additional information, contact Project 2061, AAAS, 1333 H Street, NW, Washington, DC 20005, USA.
Creating a Cooperative Classroom
by Alan Colburn & John Penick
Science Education Center
University of Iowa, USA

Cooperative learning, a powerful classroom strategy, particularly valuable for helping students learn new content and how to work together, was discussed in the March 1991 issue of this journal (Colburn & Penick, 1991). Teachers interested in cooperative learning ask: How do I do it? Where do I begin? How can I implement cooperative learning techniques in my classroom? Each of the questions is valuable, useful, and necessary.

Effective cooperative learning depends on the teacher structuring the class so that several things happen. First, small groups of students have to work together to learn something successfully or complete an assignment. Students must depend on one another in a positive way. Students are nevertheless still held accountable for their own learning; there is no freelinking. Every student, for example, will take his or her own test even if students were working together all the time leading up to the test. Finally, unlike more traditionally structured classrooms, social skills are explicitly taught to students in the cooperative classroom. For students to work together in this fashion, the teacher must provide appropriate skill development, classroom structure, strategy and encouragement.

Before outlining specific cooperative learning techniques, a few general strategies will help the teacher new to cooperative learning. The chances of success and satisfaction - on your part as well as students - are higher if the first cooperative activities are not full class period activities. Start small. Rather than groups of four, students can work in pairs. With only two students working together, the chances of students being incompatible or not doing their share of the tasks are lessened. And, a slow start will provide more opportunities to teach students how to learn cooperatively.

The first cooperative activities should also be fast, simple activities. They might, for example, last only ten minutes. With these short activities, students learn the most basic of cooperative skills, like moving their chairs from a whole group arrangement, the way chairs are set up when all students are listening to the teacher, to an arrangement more helpful for cooperative learning. Another example of a basic skill that students often have to learn is speaking in a voice quiet enough that other group members can hear, while not being so loud as to disturb members of other groups. The first attempts at cooperative learning allow the teacher to begin to find effective ways to teach his or her class these kinds of skills. This pedagogical knowledge is useful later, when the teacher is teaching more complex social skills. For the same reasons, initial group attempts do not necessarily have to involve new content. Students may use cooperative techniques in reviewing previously learned content, brainstorming, rehearsing answers to the teacher's questions, or activities addressing other non-content classroom goals.

Once teacher and students begin to feel comfortable with elements of cooperative learning, the class can then move on to fully structured cooperative strategies. Student Teams Achievement Divisions (STAD), a common cooperative strategy, is one place to start. STAD is straightforward and fits with most traditional science curricula, while still having the advantages of cooperative learning. STAD is made up of five basic components.

1. The class is presented with background content. Presentations can come from the teacher, students, or any other source of information.
2. Students then work in teams, usually of four, to prepare members to do well on a quiz (or other graded instrument that, ultimately, all will complete individually). Team members teach and help others in their small group.
3. Students then go on to take individual quizzes after team practice.
4. Team recognition for individual improvement is an important part of STAD lessons. Each student is given a base score, the minimum score that individual should achieve on a given quiz. The base score is usually based on past performance in the class. Students earn bonus points for their team based on how much their quiz scores exceed their base scores. Recognition and reward is given to any team that earns some minimum number of these bonus points. Since bonus points are awarded for improvement, all students in a group have the opportunity to contribute toward the reward. As a matter of fact, students with the lowest base scores (sometimes scorned by their peers) have the opportunity to provide the group with the largest number of
bonus points since they have the greatest opportunity to show improvement.

Teams should be selected by the teacher. High scoring and low scoring students should be together, as should students of different race and gender. The more heterogeneous the group is, the greater the opportunities for students to learn to work with and from different kinds of students.

The way one teacher uses STAD to teach students about water serves as an example of the technique in action. "I developed five labs and activities centred around the study of water," she says. "Rather than having the whole class do the same lab, each cooperative team does a different lab each day of the unit. This saves on material needs and the teams must depend only on themselves. The initial organisation takes time, but the next few days run very smoothly, and the students like this independence."

For each of five days, a team is assigned a lab activity, reading material, and a study guide on a particular water related topic. After completing a lab, students work together on a reading assignment and review for the coming quiz. Each student individually takes a quiz following the day of the lab activity.

Students are assigned a base score, the minimum score the student should (theoretically) achieve on the quiz. The students receive an individual grade earned on the quizzes and bonus points for their team based on how much their quiz score exceed their base score.

Some of her five activities include using expensive equipment the school lacks enough of for the entire class. One activity uses a stream table and another uses a computer program. By structuring the activity, students are able to explore with the stream table and the computer program for the entire class period without the teacher worrying about what to do with the rest of the class.

Discussing the five activities, this teacher says, "A cooperative unit like this takes a lot of pre-planning, and this organisation is very important if you want success. Once the labs and quizzes are set up, it is really fun to stand back, be the facilitator and observe learning taking place. The students also enjoy the independence they have in the learning process and the STAD method offers just enough competition to stimulate motivation."

On the sixth day students review everything studied during the previous five days, preparing each other for a cumulative test. Note again that each student still takes the unit test individually and receives their individual grades. However, teams receive special recognition (like extra credit) for earning the highest number of bonus points. This encourages students to help each other. The award can be agreed on by the class and teacher before the unit begins. Jigsaw technique is another common cooperative learning strategy. Students work in heterogeneous groups and each team member takes a different topic to study. They become experts on their topic by meeting with members from different teams and take turns teaching their teammates about their topics. Students are given quizzes and scoring is done the same as in STAD. Group interdependence comes when students must depend on their teammates to provide information needed to do well on the quizzes. This method is particularly successful for review of material that covers a broad spectrum. Jigsaw is a flexible cooperative learning method with an endless number of ways the teacher can modify the strategy. Presentations can replace
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quizzes, for example, or expert groups can work with sub-topics that are part of a broad class topic.

In all cooperative learning strategies, the teacher must work with groups and not do all the work personally. This means letting students make decisions within their groups, about learning and closure. If you do their thinking, they don't have to cooperate except to compete with you. Give them some room to be creative, to structure, cooperatively, their own learning.

As we pointed out last March, cooperative learning is more than merely working together. To be successful, the teacher must plan ahead, setting group goals and designing a strategy where a group can work together. This does take more time initially, but teachers report that it is quite worthwhile. They say that once students learn to work together teachers can be more relaxed and spend more time having real conversations with students. Students are seen to take more responsibility for their own (and other's) learning.

To do this, you, the teacher, may have to change your behaviour. If you take responsibility, students cannot. If you do all the evaluation and decision making, they remain passive. Structure your tasks and groups and wait; give them time. Together you can learn to make it work. Sometimes progress will be slow. Don't be impatient, it will happen. Trust us and trust them.

For further reading
Slavin, Robert E (1986) Using Student Team Learning 3rd Edition The Johns Hopkins Team Learning Project, Center for Research on Elementary and Middle Schools, Johns Hopkins University, 3505 North Charles Street, Baltimore, MD 21218, USA. This guide gives detailed instructions in the use of STAD and several other cooperative learning strategies.
Aronson, E et al (1978) The Jigsaw Classroom Sage Publications, 275 Beverly Drive, Beverly Hills, CA 90212, USA. This book provides information on using the jigsaw strategy, including a guide to teaching others about the strategy.


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USA
Portfolios
A national trend with worldwide potential

by Ronald J Bonnstetter
University of Nebraska, USA

Imagine an assessment tool that revealed a range of skills and student understandings and truly coincided with our instructional goals. Imagine an assessment that yielded more than a simple grade or a score, and allowed for input and reflection both by teachers and students. Also imagine an assessment tool that will show changes in student understanding over a period of time. And finally, imagine that this same assessment tool provided insights into what should be taught next for each and every student.

Starting with language arts, the performance-based portfolio assessment concept is gaining momentum in all subject areas throughout North America and is being discussed in Europe and Asia.

As you read this article please consider the commonality between these suggestions and processes already in place within your own programs.

As an example, how could some of the portfolio concepts and procedures be used to expand the documentation of European apprenticeship experiences? How could the Asian after-school skill development programs better document outcomes and pass this information back to the schools?

The following questions are a result of working with both in-service and preservice teachers who wanted to know more about authentic assessment and the role of performance portfolios.

The answers represent a synthesis of educational research; much of which is cited in the reference list.

This section focuses on the pre-service and in-service education of science teachers, and aims to communicate ideas and strategies which will assist science teacher educators to enhance and enrich their pre-service and in-service programs.

What does educational research say about the purpose of assessment?
The purpose of assessment should be to improve learning. However, far too many teachers view assessment as merely a tool to document what children do NOT know and make no effort to provide remediation. This missing step can only be provided when we systematically reveal how students think.

What is authentic assessment?
Authentic assessment is not a single method. It is a set of evidence that best shows progress toward goals. The extent and kinds of evidence should reflect desired outcomes and communicate not only what students know but how they think.

Therefore, authentic assessment is a set of artifacts of learning. Together, this collection provides far more than an image of a students' content knowledge. One tool that will help create this holistic view of student learning is the portfolio.

What is a portfolio?
A portfolio is a systematic, well organised, collection of evidence, used to monitor the growth of a student's knowledge, process skills, and attitudes. This assessment tool more closely matches our curricular goals by exposing what students are doing, the processes they have employed, the range of activities, the effort exhibited, as well as documenting student improvement and ability range.

How do you decide what goes into this portfolio?
There are a series of portfolio planning steps developed at the University of Nebraska which provide an excellent planning guide for any school system. By responding to each of the following questions posed in this guide, science instructional teams can collaboratively work through both the portfolio conceptual framework and formulate the documentation plan.

Developing a portfolio plan for student assessment

Creating the Portfolio Conceptual Framework

1. What kinds of assessment are currently used to assess student growth and performance in science? What do these assessments tell about student learning?
2. What are important aspects of student learning and performance that are not satisfactorily assessed with current practices?
3. What are the building-wide or school system goals that teachers expect students to know and be able to do when they leave?
4. What are the grade level curricular goals in relation to school system goals? (Each grade level should focus on different elements of the building goals.)
5. Finally, teachers should prepare goal statements for what students
should learn or be able to do and identify how each of these goals are currently being assessed.

Developing a portfolio documentation plan

1. What will be the purpose of the portfolio?

2. What documents (work samples, formal and informal tests, observation records, interviews, surveys, laboratory reports) might be included relative to each goal?

3. What are the expectations for students to demonstrate successful growth and/or learning related to each goal?

4. What initial assessment information is presently available for a student's portfolio and how will this information be incorporated into instruction?

5. Lastly, what kind of student growth documentation for each goal can be generated as part of on-going instructional activities during the year and how often will these documents be selected/obtained for the portfolio? Who will make the selections, the teacher or student, and prepare reflective captions about what a particular document shows related to each goal?

How will we grade students?

First, we must recognise that education for many years has viewed assessment as something to be scored and sterilised into a letter grade. What does that letter or number really tell us about student learning? To a certain extent all evaluation, and certainly a letter grade, is a subjective and limited assessment by a biased judge that, once stated, becomes a shadowy truth.

The first step to scoring any tool, including portfolios, is to establish criteria which reflect desired student outcomes before the actual data are collected. Many of these artifacts of learning can be broken down into levels of performance attainment, by identifying examples of the kind of work that are representative of each level.

We must remember, the reason for going to all this added work is not to throw away this rich and insightful collection of learning and record a letter grade, but to start to build a vision of student learning by documenting progress and development. The important and underlying goal is to trace learning growth and to identify skill and concept development over time. We all know that many of these desired outcomes are occurring, but past assessment procedures have not captured them.

What becomes of the portfolio at the end of the year?

The teacher's written summary assessment of student progress in both process and content acquisition closes each year's portfolio. Maintaining and passing these collections on is the real strength of portfolios. This practice allows teachers the opportunity to build from previous student knowledge and skills in ways never before possible.

Obviously, if portfolios are to be a progressive process, teachers from different grades and courses must decide the kinds of information that would be most helpful and in what format this information should be transferred.

How will teachers find the time?

This process does take time and, therefore, a commitment by all involved must be made. Time must be set aside in the form of assessment

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27
days for teachers to organise information. Conferencing sessions must be scheduled with students to review portfolio progress and teachers must be given time to meet and share individual student progress during the academic year as well as time for sharing the data in preparation for the next grade level.

What other questions concerning portfolios should be considered?

Several other questions come to mind, for example:

1. How will YOU, the teacher, use the student portfolios?
2. How will the student be involved in portfolio development or use of the portfolio?
3. Who else might find these portfolios useful?
4. What role will the administration play in helping teachers with the portfolio development process?
5. What are specific problems your school must overcome to successfully implement portfolios and what possible solutions can be generated?

Where else might this portfolio concept be used?

The portfolio concept is making its way into teacher assessment at all levels.

Evaluating college and university teaching has been an ongoing concern. Many schools are giving more weight to the role of teaching and expanding documentation through the use of teaching dossiers.

The following bibliography provides examples of publications which explain the use of portfolios to record teaching accomplishments.


Improved Performance and Promotional/Tenure Decisions
Bolton, MA: Anker Publishing Company, Inc

Seldin, P & Annis, L (1990) The Teaching Portfolio The Journal of Staff, Program & Organisation Development Vol 8 No 4, Winter

Where do teachers go for more information on student portfolios?

As previously stated, a great deal of work has been done by the language arts educators in the United States and many of their ideas can be directly transferred into science programs. However, in the last couple of years a number of excellent sources of information directly related to science have emerged. The following articles are a must for further understanding of portfolios.

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Goldman, J (December 1989) Student portfolios already proven in some schools School Administrator 46 (11)

Hamm, M & Adams, D (May 1991) Portfolio: It’s not just for artists anymore The Science Teacher 58 (5)


Krest, M (February 1990) Adapting the portfolio to meet student needs English Journal ’79 (2)

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Mills, R (December 1989) Portfolios capture rich array of student performance The School Administrator 46 (11)

Rief, L (March 1990) Finding the value in evaluation: Self-assessment in a middle school classroom Educational Leadership 47 (6)

Valencia, Sheila (January 1990) Assessment: A portfolio approach to classroom reading assessment - The whys, whats and hows The Reading Teacher 43 (4)

Varvus, L (August 1990) Put portfolios to the test Instructor

Wolf, D (April 1989) Portfolio assessment: Sampling student work Educational Leadership 46 (7)
Effects of inservice programs on elementary teachers' attitudes towards science and the teaching of science

by William Spooner & Sue Dale Tunicliffe

This article is the report of a NSTA/ASE Joint Research Project. The project, conducted from 1987 to 1988, was a comparative study of the effects of two types of inservice programs on elementary teachers' attitudes towards science and science teaching.

Purpose
The purpose of the project was to examine the effects of two types of elementary science inservice programs on elementary school teachers' attitudes toward the subject of science and toward the teaching of elementary science. These programs were designed to improve science teaching methodologies related to problem solving and thinking skills.

Design
The design of the study included a pre/post test of attitude measures to assess the effects of treatments. A comparison of the two teacher groups was made with respect to their entry attitudes towards science and teaching elementary school science. Comparison was also made on several demographic variables.

Inservice programs
The North Carolina (USA) program was of 5 days duration with 32 contact hours. Maximum opportunity was given for hands-on activities. The Richmond (England, UK) group were sent by their principals on a two day course at the Teachers Centre. The total of 10 hours contact time was divided evenly between discussion and practical, hands-on activities.

Instruments
Likert-type scales were used to measure the attitudes toward the two concepts. These scales were the Survey of Opinions Toward Teaching Elementary School Science (SOTESS) developed by Spooner and Simpson (1979) and the Science Attitude Scale (SAS) which was modified from the Revised Math Attitude Scale (REMAS) developed by Louis Aiken (1963). This scale was modified with permission from the author to reflect science.

Both scales consisted of 20 items with five possible responses - strongly agree, undecided, disagree, and strongly disagree. The most favourable response (strongly agree or strongly disagree) scored 5, and the least favourable scored 1. Items were constructed and randomly arranged so as to elicit both positive and negative responses from the respondents. The maximum score on the 20 item instrument was 100 with the minimum score 20. A score of 60 would indicate a neutral attitude toward science or science teaching. Likewise, an individual score below 40 would indicate a strong dislike for science or science teaching; a score above 80 would indicate a strong positive attitude.

Results
For teaching elementary science the North Carolina teachers' mean score was 76.39; the Richmond teachers' mean score was 77.00. Both scores were well above the neutral score of 60. The post test score shows a higher gain for the North Carolina group (4.39) than for the Richmond group (1.99).

The SAS scale for science attitude differences between the Richmond group and the North Carolina group were 1.30 points. Mean scores of 74.45 and 73.15 respectively were lower for the concept science than for the concept science teaching.

Discussion and summary
There were limitations to this study. The teachers were not randomly selected; the two workshops were not of the same duration nor at the same time; the Richmond study was conducted over a much longer time frame than the one week North Carolina study.

Nevertheless, this study has shown that these two sets of teachers hold virtually identical attitudes towards the subjects science and elementary science teaching as measured with the SAS and SOTESS instruments. Teachers in the North Carolina sample

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Section Editor
Sue Dale Tunicliffe
ICASE Project Officer
18 Octavia, Bracknell
Berkshire RG12 7YZ
UK
Table 1  Demographic details of teachers in UK and USA samples

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<th>Demographic Details</th>
<th>Richmond, UK</th>
<th>North Carolina, USA</th>
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<tr>
<td>No of Teachers</td>
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Table 2  SAS and SOTESS Pre-Test and Post-Test Results

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<th>Pre-Test</th>
<th>Post-Test</th>
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<tr>
<td>Number</td>
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<table>
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<th>Attitudes toward Teaching Elementary School Science (SOTESS)</th>
<th>Pre-Test</th>
<th>Post-Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>Mean Score</td>
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<tr>
<td>North Carolina</td>
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<td>Richmond</td>
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<td>n = 62</td>
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* significant @ 0.05 level

Table 3  SAS and SOTESS Pre-Test and Post-Test Correlation Coefficients

<table>
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<th>SAS</th>
<th>SOTESS</th>
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<tr>
<td>Richmond, UK</td>
<td>0.79</td>
<td>0.57</td>
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had statistically significant changes in a positive direction on how they felt about science and science teaching. Teachers in the Richmond sample made positive gains in attitudes as a result of the treatment but these gains were not significant at the 0.05 level. We believe a major variable is the duration of the inservice courses and the amount of actual time the teachers spend on hands-on activities (4 days in the North Carolina sample, 1 day in the Richmond sample).

The program as well as the nature of the inservice activities are variables which must be considered if we are to enhance elementary teachers' attitudes to science and to science teaching. We believe that elementary science teachers need to experience science inservice workshops in a way that will allow them to gain hands-on learning experiences that are directly replicable in the classroom.

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Stepping into Science
An ICASE Primary/Elementary Science Project

AIMS
Stepping into Science is an ICASE project which aims to:

• Establish an international network for teachers to share ideas on the teaching of primary/elementary science and technology.
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• Promote the value of science experiences for young children throughout the world.
• Facilitate professional development opportunities for teachers by including sessions on primary science and technology in regional and international conferences.

ACTIVITIES
The Stepping into Science Team is actively involved in a number of projects and activities including:

• Publishing STEPS, the Stepping into Science Project Newsletter. This newsletter contains ideas for class activities at various levels in primary/elementary schools, activities for children to do at home, comments by network members on issues, examples of children's work, lists of helpful resources and contacts. ICASE acknowledges the contribution of Philip Harris in sponsoring STEPS.
• Contributing articles and ideas for the Primary Science Section in Science Education International, the ICASE quarterly journal.
• Compiling ideas and activities for inclusion in a series of sourcebooks on the teaching of primary/elementary science and technology.
• Coordinating a scheme to encourage children to participate in science and technology activities. Certificates of Participation have been produced, and are available for schools to use in rewarding students as they complete a number of activities. Certificates are colour coded in seven different colours, so that they can be used to acknowledge progress in science from early to advanced levels within primary/elementary schools. ICASE is grateful to BP (Oman) for sponsoring this scheme.
• Organising Stepping into Science workshops and displays of children's work at national, regional and international conferences.

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Science as Part of Our Culture

by Michael Gore
Director, The National Science and Technology Centre
Canberra, Australia


While teaching Physics at the Australian National University in Canberra about ten years ago Michael Gore set up an interactive science centre called Questacon. This has been developed into the National Science and Technology Centre with Dr Gore as its Director.

In this article, the text of a speech delivered at the AGM of the South Australian Science Teachers Association in May 1991, Dr Gore outlines his belief that science is the most vital part of our culture and that there is no problem in educating and entertaining at one and the same time.

I find it interesting and instructive on occasions to ask people to list the various facets of our culture. Try the experiment some time and see how far down the list science appears. In some cases it does not make the list at all!

Very quickly you will get responses that include art, literature, music, theatre, sport, ballet, but it is instructive to observe the ranking given to science. If, as I suspect, many people do not perceive science as a part of our culture, then what do they rank as the most important part of culture as far as they are personally concerned?

The average family does not usually have an extensive library in the house. They will rarely if ever go to the theatre or attend a live symphony concert. The walls of their homes will not be adorned with too many oil paintings or numbered prints. However, if one were to carry out an inventory of devices having their origins in science and technology, I predict that the list would be quite extensive. It would be bound to range from such items as electric lights to microwave ovens, radios, telephones, compact disc players, freezers, dishwashers, television sets, video players, computers, washing machines, amplifiers, tape recorders and a host of other items which are all products of that part of our culture which is called science.

We who study and teach science are indeed fortunate. It is a discipline that never palls, that never becomes tedious. There are always new horizons to be reached. In a whole lifetime it is not possible to 'know' everything about a particular branch of science.

Konrad Bloch, a German biochemist, made the following observation when accepting his Nobel Prize in 1964:

Science is, in the best and strictest sense, glorious entertainment.

Science is a firm, reliable, orderly, logical discipline. The ground that is science does not shift under your feet; not like some other disciplines! There is a story about the man who returned to his university 30 years on and visited his old economics lecturer who had risen to become a revered professor. They reminisced about the old days and the visitor noticed an examination paper lying on the coffee table. He picked it up and scanned it with avid curiosity. He was amazed at what he read! 'These questions,' he exclaimed 'are exactly the same as those that appeared on a paper I sat 30 years ago.' 'Ah yes,' said the Professor, 'but today the answers are different'.

I quoted Konrad Bloch as saying that science is 'glorious entertainment'. This sums up part of my own personal philosophy of teaching. I believe that there is absolutely no problem in educating and entertaining at one and
the same time. There are those however who believe that it is an anathema to be entertained by science. Many hold the view that science is a very serious part of our culture - and that to utter the words science and entertainment in the same breath is tantamount to sacrilege. But is this really so? If it is - then I assert that it is this sort of thinking that has made a major contribution to the layperson's perception of science. We do not adopt the same attitude to other parts of our culture. No one would consider that there is anything amiss about being entertained by a performance of Beethoven's Violin Concerto, or for that matter enjoying a production of Shakespeare's tragedy Macbeth.

People expect to be entertained by Handel's Messiah or by a performance of Swan Lake. Until now, we have not been entertained by science.

Because of this attitude, the general public have come to view science as something that belongs to scientists alone, something the average layperson can neither share nor understand.

The way science has been taught in some cases has directly contributed to this situation. All too often it has been presented in a mind-dulling way, with no compassion or humour, a subject to be learned and memorised. My first physics teacher in Lancashire did it this way. He had neither interest in nor knowledge of the subject and his lack of enthusiasm was infectious. I came to believe, in common with many students today, that physics is about memorising formulae and then solving some curious meaningless problems by plugging in numbers.

At the Australian National University (ANU), where I taught physics for twenty five years, I found that most first year students came to us with the firm conviction that physics was about learning formulae. They apparently got this impression from their school days. This I found particularly worrying as, in common with all other universities, we were admitting top class secondary students.

It must have been back in the early seventies that the staff of the ANU Physics Department adopted a new tactic with first year students. In order to demonstrate that we wanted them to understand concepts and not memorise formulae, we introduced the practice into our first year classes of giving all the students a printed list of every formula that was derived in the first year course.

We distributed this list in the first lecture of the year and told the students that they would be allowed - nay, encouraged - to take it into all tests and examinations throughout the academic year. We went even further by telling them that anyone who forgot their crib sheet would be provided with a new copy as they entered the examination hall. You can imagine the consternation this caused.

Although one of my teachers nearly turned me away from physics for life, Alfred Whitaker did the exact opposite with regard to mechanics. He taught the subject with flair and humour. He made us laugh a couple of times in each class and as a result we loved him and we came to share his love for the subject he taught. He was an inspired teacher - and he inspired us.

It was that man back in 1947 who demonstrated to me that teaching was a very worthwhile thing to do with one's life. I have always had nothing but contempt for George Bernard Shaw when he said that 'Those who can, do; those who can't, teach.' In the immortal words of Henry Ford, and unashamedly mixing my quotations, that statement is 'bunk'.

The philosophy that I have evolved for myself over the years with regard to science teaching is that, to be successful and effective, the teacher must be an actor. The theatre of course is a revered facet of our culture. I believe that if I am to inspire the people to whom I speak, if I am to inspire them to find out more - to learn - then I must by my actions enthuse and excite them. I must present the subject matter with enthusiasm, humour, imagination; and I must - this is very important for science - make it relevant to the everyday world - the world with which my listeners are very familiar.

Robyn William's portrayal of a school teacher in the movie Dead Poets Society may be a little 'over the top' but it demonstrates what I mean by an imaginative presentation. I believe that science teachers at both secondary and tertiary levels have a great responsibility to exercise their skills to change the public's perception of science.

There is also a more worrying aspect about secondary teaching and that is that I believe that the teaching profession is not valued by the community as highly as it deserves. I know many teachers who feel that they are considered to be second rate citizens in relation to what they do. I believe that there are many people in the community who see teachers as little more than glorified childminders between the hours of 9.00 am and 3.30 pm. The problem of course is not simply concerned with science teachers - I believe the problem is spread right across all the teaching disciplines. If this regression is not halted, the implications for Australia will be horrendous by the time we reach the year 2000.

I believe that some incentive must be offered in the tertiary arena to ensure that excellence in teaching is rewarded. At present there is absolutely no incentive to try to teach well in universities. It is easy to judge an academic's research output, but rather more difficult to judge the quality of a person's teaching - but not impossible, and it must be done if we really believe that it is worth doing.

Since I left my teaching post at the Australian National University, I have been working on the task of trying to alter the general public's perception of science and its role in our society. The interactive science centre was introduced into Australia in the early 80s and since then little centres have spread across the country like wildfire.

The Questacon was established in Canberra in 1980 and since then, interactive science centres have been established in Brisbane, Newcastle, Wollongong, Perth and later this year The Investigator will open its doors to the public in Adelaide.

For those of you who might be wondering what an interactive science centre is, it is a place specifically designed to encourage the public to
'mess about' with science. There are a host of activities laid on that visitors can be actively engaged in doing.

David Attenborough wrote an article a few years ago in which he described how many conventional museums were beginning to include new style interactive exhibits in their collections. He described how he had taken his eight year old son to visit the Victoria and Albert Museum in London and how they spent the day looking at its many priceless treasures. Attenborough described how, when they got home, he asked his son what, out of all the marvellous things he had seen that day, he had enjoyed the most. Without hesitation the young boy answered - the revolving doors.

The attraction and fascination of interactive science centres can best be summed up in the old oriental proverb:

*When I hear I forget, When I see I remember, But when I do, I understand.*

Our culture has introduced concert halls where the public can involve themselves in an appreciation of music even though they may not be able to read a note of music, let alone compose a symphony. We have had theatre from the earliest times and can enjoy plays without being playwrights. And we all from time to time, browse - mess about - in libraries even though we'll never write a novel.

Interactive science centres began their spread across the globe from about 1968, and all are places where you can 'mess about' with science, without any qualifications except the desire to explore. It is my belief that such centres along with many other different endeavours will help in time to change the public's attitude to science. These centres are designed to enable people to discover for themselves that science is a thoroughly entrancing and entertaining part of our culture.

Questacon - The National Science and Technology Centre in Canberra is dedicated to raising the public's awareness of science and technology. It attempts to let the public see how science is part of our everyday life, how science is part of our culture.

The Centre is in the Commonwealth Department of the Arts, Sport, the Environment, Tourism and Territories. Although the word culture does not rate a mention in the title of the portfolio, Questacon is in fact within its Cultural Branch.

One of several initiatives to come out of the establishment and expansion of Questacon - The National Science and Technology Centre has been the Australian National University's Graduate Diploma Course in Science Communication. This is a post graduate program - we believe the first of its kind in the world - that is run jointly by Questacon and the ANU. It is open to science and engineering graduates who, in addition to having a science or engineering degree, must also demonstrate at audition that they have an engaging personality and can communicate in a lively and confident way.

The National Science and Technology Centre with all its programs is based on the foundation of education. What you as teachers do, what the National Science and Technology Centre does, is to show, each in their own way, that science is at the root of everything - and that it is the most vital part of our culture. Anatole France wrote in 1983:

*Do not try to satisfy your vanity by teaching a great many things. Awaken people's curiosity. It is enough to open minds; do not overload them. Put there just a spark. If there is some good flammable stuff, it will catch fire.*

---

**Interactive Science Centres in Australia**

Questacon - The National Science and Technology Centre
PO Box E28, Queen Victoria Terrace, Canberra ACT 2600

The Investigator
PO Box 399
Goodwood SA 5034

Scitech Discovery Centre
City West Complex
Railway Parade
West Perth WA 6005

Science Centre
University of Wollongong
Campus East, Cowper Street
Fairy Meadow NSW

Supernova
Newcastle Regional Museum
78 Hunter Street
Newcastle West NSW

Science Centre
Queensland Museum
Cnr William St & Stephens Lane
South Brisbane Qld 4101

Launceston Science Centre
Queen Victoria Museum & Art Gallery, Wellington Street
Launceston Tas 7250

Powerhouse Museum
500 Harris Street
Ultimo, Sydney NSW

Kidseum
Sydney Children's Museum
Cnr Pitt & Walpole Streets
Merrylands NSW 2160

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*Photo: Questacon - The National Science and Technology Centre on the shores of Lake Burley Griffin in Canberra, Australia*
The Second IEA Science Study

The three volumes of the Second IEA Science Study, available from Pergamon Press, present a comprehensive view of science education around the world.

The IEA Study of Science I: Science Education and Curricula in Twenty Three Countries Edited by Malcolm J Rosier and John P Keeves

This 318 page volume makes comparisons between countries in terms of the conditions under which science is taught, the organisation of science teaching, the emphasis on different science content areas and on the process of science, the focus of decision-making with respect to the science curriculum, and the penetration of new ideas in science teaching. Consideration is also given to the fair and valid assessment of science education across countries. Reports on the provision of science education in each country studied are included. Cost £26.50.

The IEA Study of Science II: Science Achievement in Twenty Three Countries Edited by T Neville Postlethwaite and David E Wiley

This 248 page volume presents the data on students, teachers and schools for each country and analyses the science performance of the students and their attitudes towards school and science. Further themes include the opportunities available for learning science, the qualifications and teaching load of staff, the structure of the science curriculum, and the influence of home and school circumstances on science achievement. Cost £25.00.

The IEA Study of Science III: Changes in Science Education and Achievement: 1970 to 1984 Edited by John P Keeves

This 320 page volume considers the shifts in science education and achievement from 1970 to 1984 in Australia, England, Finland, Hungary, Italy, Japan, The Netherlands, Sweden, Thailand and the United States (the countries that took part in both the first and second IEA Science Studies). Specific chapters address such issues as the influence of attitude on science achievement, gender differences, beginning science in the elementary school, the influence of home circumstances on achievement and on educational and occupational expectations, and the teaching practices which enhance the learning of science. Of particular interest are the examinations of the changes in achievement in the 10 and 14 year old age groups, in the conditions under which science is taught, and in the science curriculum. Cost £52.00.

NEW ICASE PUBLICATION

Industry - Education Liaison

ICASE YEARBOOK 1990

Based on a symposium held in Brussels 5-7 September 1990

The 1990 ICASE Yearbook, sponsored by CEFIC (Conseil Europeen Des Federations De L’industrie Chimique), is a timely publication. The collection of papers presented at the Seminar on Industry-Education Liaison acknowledges the critical importance of partnerships between industry and education. The Seminar, held from the 5th to 7th September 1990, was organised to: (1) provide opportunities for the exchange of information and experiences in schemes for industry-education liaison; (2) develop models for industry-education liaison; (3) establish, through ICASE, a network for information exchange for future developments; (4) publish a resource book for teachers and administrators on industry-education liaison.

The Yearbook addresses a variety of topics, for example: An Overview of Demographic Trends in Industry; Chemical Industry Education Centre: Exciting Science and Engineering; Cologne Model: Chemistry-Technology-Everyday Life; Contact between School and Working Life in Sweden; Forms of Cooperation between the Chemical Industry and Secondary Schools in the Netherlands; and The Planning and Organisation of Industry Study Tours. A Summary of Seminar Discussions outlines some key principles and proposes a course of future action.

Copies, at a cost of US$7.50 or £4.50 plus 25% postage, can be ordered from:

Dennis Chisman, Honorary Treasurer, ICASE
Knapp Hill, South Harting, Petersfield GU31 5LR, UK
Cheques payable to "ICASE"

Another new release from Pergamon Press is the following publication.

Issues in Science Education: Science Competence in a Social and Ecological Context Edited by Torsten Husen and John P Keeves

This 262 page publication presents a collection of papers from the international symposium Science and Education in the 21st Century held at the Royal Swedish Academy of Sciences as part of a celebration of their 250th anniversary. The papers present state-of-the-art of science teaching and discuss the main questions facing teachers. Cost £24.95.
Education and Training in Chemistry in Europe

A new publication available from ICASE
A Royal Society of Chemistry Publication

The Royal Society of Chemistry - an ICASE member association - has published a new edition of Education and Training in Chemistry in Europe. This 180 page book contains descriptions of the education systems of 25 European countries and a series of comparison tables covering chemical education from primary level through to university and higher education levels.

It has been produced for the Federation of European Chemical Societies (FECS) with support from Unesco and the Royal Society of Chemistry.

Copies can be purchased at a cost of £10.00 each plus 25% postage and packing from the following:

Honorary Treasurer, ICASE
Knapp Hill, South Harting
Petersfield GU31 5LR
UK
Cheque payable to
‘ICASE’

Royal Society of Chemistry
Burlington House
Piccadilly, London W1V 0BN
UK
Cheque payable to
‘Royal Society of Chemistry’

Who’s Who in Science Education Around the World
1991 Edition

Published by ICASE with assistance from Unesco

This biographical volume is now available from:

Brenton Honeyman
Editor
Who’s Who in Science Education
10 Hawken Street
Monash ACT 2904
Australia

This new ICASE publication contains brief profiles on prominent science educators, their work, their projects and their interests. The valuable reference book includes key women and men in many countries throughout the world who are contributing to science education at primary, secondary or tertiary levels.

The information will help readers to contact colleagues in both developing and developed countries who may be working on projects of interest to them, who may be potential speakers at upcoming meetings or conventions, and who may be invited to work on collaborative projects.

Copies are being distributed to ICASE member associations, institutions, centres, foundations and companies, and to international science education organisations including UNESCO, ICSU Committee on Teaching of Science, etc. Copies are also being distributed to those who have sent pre-paid orders.

Further copies at the price below are available from:

Brenton Honeyman
ICASE Publications
10 Hawken Street
Monash ACT 2904
Australia

Please enclose a cheque payable to ‘ICASE’ for:

• US$15.00 (includes postage)
• UK£9.00 (includes postage)
• A$20.00 (includes postage)

Journal of Elementary Science Education
Call for Manuscripts

The Journal of Elementary Science Education invites submissions of manuscripts written in accord with its purposes that have not been previously published and are not under review by any other publication.

The JESE, published biannually, is a national, refereed journal devoted exclusively to the issues of elementary science education. The purpose of the journal is to communicate ideas, theoretical formulations, research findings, and practical field-oriented information related to supervision, curriculum and instruction. Lesson activities alone are generally not accepted. The audience of the JESE includes colleges and universities with teacher education programs, State Departments of Education, local education agencies, science educators, and science teachers.

Manuscripts, which should generally be limited to 15 pages, should focus on issues related to elementary science education theory, research or practice including, but not limited to the following interest areas:

• Needs assessment, research and evaluation
• Preservice teacher preparation
• Inservice teacher enhancement
• Recruitment and retention
• School board policies and practices
• Teaching and learning
• Gifted/special education
• National/international issues
• Public/private school administration

Please send manuscripts to: J. Preston Prather, Editor, Journal of Elementary Science Education, Curry School of Education, CISE - 250 Ruffner Hall, University of Virginia, Charlottesville VA 22903-2495, USA

36
ICASE is keen to arrange regional or world events for the benefit of member associations. If your association or organisation is interested in hosting an international seminar, workshop or conference, contact the Executive Secretary or your Regional Representative. To gain ICASE endorsement, the meeting must be international in nature, open to member associations, and, while all sectors of the science education community should be encouraged to participate, must be relevant to classroom teachers.

1991

December 27-29
33rd Annual Conference of AISTA
Location: Campus of Bharatiya Vidyavashram, Jaipur, India
Contact: Mr R K Mohta, HQ Secretary, AISTA, 31 Jangpura Road (Rear), Bhogal, New Delhi 110014, India
The next Conference of the All India Science Teachers Association (AISTA) will be held in the campus of Bharatiya Vidyavashram during December. The theme is Science and Values. Subthemes are (1) Science curriculum for the future citizen; (2) Attitudes in science teaching; (3) Science and the value of experiments. Papers will be published in the journal Vigyan Shikshak. An exhibition of teaching aids prepared by delegates will be a special feature of this conference.

1992

January 3-6
ASE Annual Meeting
Location: University of Sheffield, Sheffield, UK
Contact: Annual Meeting Secretary, ASE Headquarters, College Lane, Hatfield AL10 9AA, UK
Full details of this large international event have been circulated in Education in Science, a journal of the Association for Science Education.

March 26-29
NSTA National Convention
Location: Boston, MA, USA
International delegates are invited to participate in the International Round Table - one of the many features of this large convention. Each country is provided one or more tables in a large room where delegates can display and present information on science education in their country. Visitors move from table to table, talking with the various representatives. If you require an invitation to participate, write to John E Penick, Professor and Coordinator, Science Education Center, The University of Iowa, Iowa City, Iowa 52242, USA.

March 29 - April 10
Seminar on Science Teacher Education
Location: Centre for Educational Studies, King's College London, UK
Contact: Courses Department, The British Council, 10 Spring Gardens, London SW1A 2BN, UK
This British Council International Seminar will be directed by John Head and John May of King's College Centre for Educational Studies, University of London, and will focus on secondary level teacher education, although some aspects will be of interest to those involved in primary science teaching. Six areas will be addressed: What is the nature of science education for schools?; To what extent should teacher education reflect and shape societies' values and cultural traditions?; How can we aid their professional development so that science teachers have the skills they need in the classroom and laboratory?; What can the results of research tell us about new ways to approach children's learning and classroom practice?; How is the work of pupils, teachers and trainees to be evaluated?; How does the structure of national and regional administration affect the management of teacher education? There are vacancies for 30 international participants: practising teacher trainers, advisers, inspectors, organisers of professional development programs and policy maker.

April 26-May 1
International Conference on Technology Education - INCOTE 92
Location: Weimar, Germany
Contact: Dr D Blandow, INCOTE 92, Pädagogische Hochschule, Nordhäuserstraße 63, 0-5063 Erfurt, Germany
This symposium will be the first pan-European meeting on technology education to be held in Germany. The principal aim of the symposium, which is being organised in collaboration with a number of organisations including ICASE and INISTE, will be to discuss technological literacy and competence in technology education within a European dimension. The majority of participants will be from European countries, with a few key people from other regions of the world. The principal language of the symposium will be English.

May 11-15
Second International History Philosophy and Science Teaching Conference
Location: Queen's University, Kingston, Ontario, Canada
Contact: Prof Skip Hills, Faculty of Education, Queen's University, Kingston, Ontario, Canada K7L 3N6
This conference follows the very successful First International Conference on History, Philosophy and Science Teaching held at Florida State University in November 1989. All conference papers will be published in advance of the conference. Accounts of the application of history and philosophy of science in the science classroom are welcome, as are research papers on the issue.

May 11-22
Seminar on Developments in Primary Science Education
Location: Liverpool, UK
Contact: Courses Department, The British Council, 10 Spring Gardens, London SW1A 2BN, UK
This British Council Seminar will examine major concerns and activities in primary science in the UK as well as their international context and implications. Major research and development projects in the area of science and technology relevant to the primary phase will be represented, including Learning in science, Research into children's ideas, Contexts of learning, Out of school learning, Curriculum development and evaluation, Pupil assessment, and Teacher education. There are vacancies for 35 participants, including science educators and curriculum developers concerned with the primary phase.

June 10-12
ICASE Research Seminar on Chemistry and Physics Education
Location: University of Dortmund, Germany
Contact: Prof Dr Hans-Jürgen Schmidt, University of Dortmund, Department of Chemistry, Otto-Hahn-Straße, 4600 Dortmund 50, Germany
This symposium on empirical research in chemistry and physics education will focus on the methodology of empirical research in this field. There will be approximately 12 presentations each followed by a discussion period. The language of the symposium will be English. Presenters will be asked to send their paper beforehand, ready for printing as Proceedings through ICASE. Proposals of about 3 pages should include title, background, method, results, discussion, implications for research and teaching, and references, and should be sent to the contact above no later than August 31, 1991. General papers will not be accepted. Although there will be no seminar fee, participants will need to cover their own expenses.

July 6-10
CONASTA 41
Location: Perth, Western Australia
Contact: Convenor, CONASTA 41, Science Teachers Association of WA, PO Box 991, West Perth, WA 6005 Australia
The Australian Science Teachers Association invites you to participate in the forty first annual conference of the Association.

August 2-10
Eighth ICASE Asian Symposium
Location: Colombo, Sri Lanka
Contact: Mr Asoka Veerasinghe
Hon, Joint Secretary, SLASME, Institute of Computer Technology, PO Box 1490, Colombo, Sri Lanka
Science educators are invited to attend the eighth ICASE Asian Symposium and enjoy the natural beauty of the country and the hospitality of the Sri Lankans. The Symposium, organised jointly by ICASE and the Sri Lanka Association for Science and Mathematics Education (SLASME), will feature outstanding speakers from many countries who will address the theme "Science Education for a Changing World". The Symposium aims to identify some of the changes affecting our daily lives and to discuss ways by which science education can respond to those changes. Subthemes include (1) technology, (2) appropriate technology, (3) environment, and (4) scientific literacy. Participants will be able to experience the world famous pageant "The Kandy Perahera" in Sri Lanka. 100-150 science and mathematics educators from all parts of the world, and 200-250 local delegates are expected to participate in this event.

August 31 - September 3
SCICON Biennial Conference of NZSTA
Location: University of Waikato, Hamilton, New Zealand
Contact: Neal Uting, Education Advisory Service, 4 Hill Street, Hamilton, New Zealand
The theme of SCICON for 1992 will be Science - Technology . . . A Partnership. Information and registration forms about the biennial national conference of the New Zealand Science Teachers Association can be obtained from the contact above.

December 17-21
Twelfth International Conference on Chemical Education
Location: Bangkok, Thailand
Contact: Dr Somjai Wichaidit, The Secretariat - 12th ICCE, c/o Research Centre, Faculty of Medicine, Ramathibodi Hospital, Rama 6 Road, Bangkok 10400, Thailand
The theme of the Twelfth International Conference on Chemical Education will be Chemistry in Transition and it is hoped that the participants will interpret this in many different ways. This biennial Conference, to be held for the first time in South East Asia, is organised by the Committee on Teaching of Chemistry of the International Union of Pure & Applied Chemistry, and The Chemical Society of Thailand in cooperation with UNESCO. It is attended by chemistry teachers at both high school and university levels who wish to improve their teaching and to learn from one another techniques and experiences. A second circular including instructions for submitting abstracts and registration will be mailed in March 1992 to those responding to the address above.
January 3-8
International Conference on Science Education in Developing Countries
Location: The Amos De-Shalit Israeli Science Teaching Center, Israel
Contact: Conference Secretariat, ORTRA Ltd, 2 Kaufman St, PO Box 50432, 61500 Tel-Aviv, Israel (conference arrangements) or Dr Avi Hofstein, Department of Science Teaching, The Weizmann Institute of Science, Rehovot 76100, Israel (academic correspondence)
This international conference on the theme "Science Education in Developing Countries: From Theory to Practice" will review past experiences and achievements in science education and plan for the 21st century with a special focus on developing countries. The conference will feature plenary lectures, symposia, poster sessions, workshops, exhibitions, informal discussions, social events and local visits. Topics for symposia and plenary lectures will focus on current research on learning and teaching and its implications for (1) the learner, (2) the teacher, (3) the classroom, and (4) the curriculum.

June 27 - July 3
VII Pacific Science Inter-Congress
Location: Okinawa Convention Center, Okinawa, Japan
Contact: VII Pacific Science Inter-Congress, c/o Section of International Affairs, University of the Ryukyus, 1-Senbaru, Nishihara, Okinawa, 903-01, Japan
The symposium will be organised around the theme The Pacific: Crossroads for Culture and Nature and subthemes (1) Cultural Interchange among Pacific Peoples; (2) Speciation, Dispersal and Conservation of Species in the Pacific; (3) Towards Appropriate Technologies and Policies for Development and for the Conservation of Natural Environments in the Pacific. Scientific sessions organised by the Scientific Committees of the Pacific Science Association focus on a range of science disciplines and issues, including Science Communication and Education.

July
Conference 93
Location: Paris, France
Contact: Dr Jack Holbrook, ICASE Executive Secretary, Department of Curriculum Studies, University of Hong Kong, Hong Kong.
This worldwide conference, organised by ICASE in conjunction with Unesco and other international bodies including ICSU Committee on Teaching of Science, is the second phase of the three phase Project 2000+ (refer to September 1991 issue for more details of this project). A number of international and regional conferences will generate input into Conference 93. The theme of the conference addresses the issue of Scientific and Technological Literacy for All. Sessions will establish agendas for future action. The majority of delegate places will be filled by invitation.

ICASE ENDOWMENT FUND

Associations and individuals are invited to contribute to this fund to support the activities of ICASE

For further details, contact

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Science Education International

The Journal that keeps you up to date with what's happening around the world

Are you planning a regional or international meeting?

Contact the Editor to have details included in this section

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Extending and improving education in science
for all children and youth by assisting
member associations throughout the world

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Science Education International is the Quarterly Journal of the International Council of Associations for Science Education. ICASE was established in 1973 to extend and improve education in science for all children and youth by assisting member associations throughout the world.

This journal provides a means for associations, institutions, centres, foundations, companies and individuals concerned with science education, to share perspectives, concerns, ideas and information which will foster cooperative efforts to improve science education, and which will serve as a chronicle of the advancement of science education throughout the world.

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ICASE News

Feature Articles
A Caribbean Physics Syllabus and the History of Physics
Peter Whiteley
Research Rookies: A Highly Successful Industry-Education Liaison Program
II DePhillips, KR Roy, ES Shamroth

Science Education Around the World

12
Research for Teaching and Learning

16
Teacher Self Evaluation
JE Penick

Science Teacher Education

21
Reflective Writing to Enhance Communication and Learning
R Bonnstetter

Primary Science

23
Science Technology Society

26
Special Feature: ICASE World Activity Day on 14 October

Resources

31
Calendar

33

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Looking forward to 1992

By Brenton Hemony
ICASE Journal Editor

This year is packed with events and meetings which will continue to strengthen the ICASE network of member associations.

The year began with the release of the new ICASE Publication Who's Who in Science Education Around the World 1991 Edition. This first edition contains brief profiles on prominent science educators, their work, their projects and their interests. The information will help readers to contact colleagues in both developing and developed countries who may be working on projects of interest to them, who may be potential speakers at upcoming meetings or conventions, and who may be invited to work on collaborative projects. Copies have been distributed to ICASE member associations, institutions, centres, foundations and companies, and to international science education organisations including Unesco, and the ICSU Committee on Teaching of Science.

The ICASE Executive will be meeting in London during April. The long agenda reflects the growth in the number of programs managed by ICASE. Their remains a critical factor in the delivery of these programs - the continuing need for additional human resources! The development of a 5 year plan for the Association acknowledges this critical factor.

At the conclusion of the Executive Meeting, a number of members will meet to further the planning of Conference 93 'Scientific and Technological Literacy for All' to be held in Paris in July 1993. The planning team has been working closely with Unesco and other participating organisations to prepare for this big event – the second phase of Project 2000+ (a joint ICASE-Unesco initiative).

One of the key conferences which will link with Conference 93 is INCOTE 92, the International Conference on Technology Education. This pan-European event is an ICASE endorsed meeting, and is being held at Weimar in Germany from 26th April to 1st May. At this meeting, ICASE is conducting a symposium on 'Science and Technology Education – A Vital Link'. The symposium will highlight the debates surrounding the place of technology education in the school curriculum and, in particular, in school science programs. This meeting will also be considering the establishment of a world-wide technology education association – a development which is being followed closely by ICASE.

Another ICASE event in Germany is scheduled for 10th - 12th June at the University of Dortmund. The ICASE Research Seminar on Chemistry and Physics Education will continue to generate important outcomes in the tradition of the previous two events and will also provide a valuable input to Project 2000+ and Conference 93.

An ICASE Asian Symposium on 'Science Education for a Changing World' will be held in Sri Lanka during 2nd - 10th August. As a feeder event to Conference 93, the outcomes of this symposium will feed directly into Project 2000+.

A little later in the same month (17th - 22rd August), the Science Teachers Association of Nigeria is organising an International Seminar on a Conducive Classroom Environment for Science, Technology and Mathematics Education in Enugu, Nigeria.

October 14th has been designated as ICASE World Activity Day. On this day, schools around the world are encouraged to participate in special activities. This year, in concert with ISY (International Space Year), the activities will be on a space theme and will be appropriate for primary and secondary schools. ICASE member associations are encouraged to promote these activities as widely as possible to teachers in their country. Some special activities are outlined later in this issue.

The Second ICASE Industry-Education Seminar is being organised in Europe as a followup to the successful seminar held in 1990.

While all this activity is going on, ICASE is continuing to develop a range of publications. Science Education International continues to experience growth in subscriptions as it becomes more well known. Other publications are planned during 1992. And this is just the start . . . !
Eighth ICASE Asian Symposium

Colombo, Sri Lanka
2-10 August 1992

Science Education for a changing world

Organised jointly by ICASE and the SLASME

Contact:
Mr Asoka Weerasinghe
Hon. Joint Secretary
SLASME
Institute of Computer Technology
PO Box 1490, Colombo
Sri Lanka

News from Jamaica

The Annual Meeting of the Association of Science Teachers of Jamaica (ASTJ) was held on 28th - 29th November 1991 in Kingston, Jamaica. The ASTJ is one of the oldest science teachers associations in the Caribbean and Latin America, having been established in 1950. It became a foundation member of ICASE in 1973. The theme of the 1991 Conference was 'Science for Young Jamaica - Partnership for Development'. In addition to reports from local projects for formal and non-formal science education, there were three plenary lectures by overseas visitors including: Mr Bill Aldridge, Executive Director of The National Science Teachers Association (NSTA), USA; Mr Dennis Chisman, Hon Treasurer, ICASE, UK; and Prof Napoleon Bryant, Xavier University, Cincinnati, Ohio, USA.

The new Chairman of the ASTJ is Ms Vilma McClennan of the UWIDITE Unit at the University of West Indies in Kingston, Jamaica. This, together with a newly-established interactive Learning Centre on the campus of the University of the West Indies, will provide a resource and library base for the Association and accommodation for meetings.

Review of Literature on Scientific and Technological Literacy

In preparation for the major UNESCO-ICASE Conference to be held in Paris during 1993 as part of Project 2000+, ICASE is completing a review of the literature on scientific and technological literacy.

Please send any articles or abstracts on these subjects to:
John E Penick
Science Education Center
789 VAN
University of Iowa
Iowa City, Iowa 52242
USA

All submissions will be acknowledged in the review.

Coming ICASE Events

For further details about these ICASE endorsed events, consult the Calendar in this issue.

April 26 - May 1, 1992
INCOTE 92 International Conference on Technology Education, Weimar, Germany
Contact: Dawn Robertson, Janet Jones Associates Ltd, Westfield College, Queens Building, Kidderport Avenue, London NW3 7ST, UK

June 10-12, 1992
ICASE Research Seminar on Chemistry and Physics Education, University of Dortmund, Germany
Contact: Prof Dr Hans-Jürgen Schmidt, University of Dortmund, Department of Chemistry, Otto-Hahn-Straße, 4600 Dortmund 50, Germany

August 2-10, 1992
Eighth ICASE Asian Symposium, Colombo, Sri Lanka
Contact: Mt Asoka Weerasinghe
Hon. Joint Secretary, SLASME, Institute of Computer Technology, PO Box 1490, Colombo, Sri Lanka

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International Science Activities

A Call for Contributions

by R Lepischak
President, ICASE

If you have an interesting science activity (for any age level) which can be described in one page, please send to:
Bob Lepischak
President ICASE
Box 63, Neepawa
Manitoba
Canada ROJ 1HO

These activities will be compiled into an ICASE publication.
A Caribbean Physics Syllabus and the History of Physics

by Peter Whiteley
Faculty of Education, University of the West Indies
Mona Campus, Kingston 7
Jamaica

Introduction
The majority of the English-speaking territories of the Caribbean obtained their political independence from Britain in the 1960's and 1970's. However, even after independence there continued to be reliance on the examinations set at Ordinary and Advanced level by British Examination Boards (mainly Cambridge and London). It became accepted that such reliance was not in the long term interest of the peoples of the Caribbean. A variety of cultural biases could be discerned in the syllabuses and examination papers and the lack of any substantial involvement of Caribbean educators in the process of examining tended to place limits on the quantity and quality of feedback from the examiners to the teachers and students concerned.

In order to address the issues mentioned above, amongst others, the Caribbean Examinations Council (CXC) was established in 1972 by the regional governments and now serves sixteen territories in the Caribbean region (CXC 1978, CXC 1982). Its mandate was to provide relevant secondary school-leaving examinations for candidates of age 16+ years and ensure that the standard of such examinations was regionally and internationally recognised.

Two levels of examination, Basic and General Proficiency, are offered by CXC, the former normally aimed at satisfying the needs of a school leaver who is to start work and the latter intended to provide a foundation for further study. The chemistry, biology and physics syllabuses were introduced in 1983 and first examined in 1985. These subjects were introduced at the General Proficiency level only. All three syllabuses have recently (1991) been fully revised. An integrated science syllabus, at both Basic and General levels, is available for those who need a more general science background.

The Development of the CXC Physics Syllabus
CXC syllabuses are developed by subject panels which consist of curriculum specialists from Ministries of Education of the territories involved, practicing teachers and members of staff from the regional universities. During the initial period of development wide-ranging consultation occurs which allows interested individuals and organisations to submit views to the panel. The intention is that syllabuses and examinations take account of the needs of the Caribbean, reflect the nature of the societies within the region and explore relevant regional issues. Science syllabuses and examinations might, for example, be expected to utilise Caribbean examples of the applications of science.

A separate committee of three persons is responsible for the setting of the examination papers each year.

Taba (1962) suggested that the first steps in planning a curriculum should be the diagnosis of needs and the formulation of objectives to satisfy those needs. The selection and organisation of suitable content would follow. However, in the case of the CXC physics syllabus (1985) it appears that its content was primarily influenced by the Cambridge and London Examining Board syllabuses which were in use in the Caribbean in the early 1980's. The structure and order of the topics in the CXC syllabus is such as to encourage what might be described as a 'traditional' approach to the teaching of the subject. The content is arranged 'vertically', that is, in the order of development of the individual topics and the teacher (or student) is left to make the 'horizontal' links across the syllabus that unify the subject at a more fundamental conceptual level. All the 'usual' topic areas are in the syllabus, that is, mechanics, heat, light, sound, waves, electricity and magnetism and modern physics. General objectives are stated for each section and for practical work, and content is outlined with specific objectives written in broad behavioural terms. Overall, sixteen aims for the syllabus are specified and these may be classified as three content-based aims, eight process-based and five of an attitudinal nature.

A novel aspect of the 1985 CXC physics syllabus was the introduction of aspects of the history of physics and the historical development of some of the central concepts and models. Part of this material consisted of accounts of the lives of scientists concerned. However, the more interesting material was that in which previous scientific models (which now might be described as 'discredited') had to be known and understood. The students also needed to be aware of some of the ideas and experiments that led to the acceptance of the new models - the process of change that Kuhn (1970) referred to as a scientific revolution when the paradigm within which scientific research is carried out is replaced by a more useful paradigm.

Three major paradigm shifts were embedded within the CXC physics syllabus. They were:
(a) Aristotelian to Galilean/Newtonian theory of mechanics
(b) Caloric to kinetic theory of heat
(c) Particle to wave theory of light

In each case the syllabus asked for knowledge of both a previous and the presently accepted paradigm. In (b) and (c) a knowledge and understanding of a crucial experiment which
supported the new model was also required.

In the revised syllabus some rearrangement of the content has occurred and most of the biographical details of the scientists removed. However, the majority of the historical material of the 1985 syllabus appears in the new syllabus. The introduction of such material appears to reflect (or even pre-date) general trends as there is now considerable international interest in the utilisation of the history of science in high school science courses.

Sherratt (op cit) in his historical review of the history of science in the science curriculum, listed some of the wide variety of roles that have been seen for the history of science:

(i) as a source of experiments that allow easy illustration of fundamental scientific principles
(ii) as a useful teaching aid for aspects of science that do not allow for an experimentally-based development
(iii) to provide moral training (presumably Sherratt is referring to the attitudes and values displayed by the scientists)
(iv) to demonstrate the cultural and humanistic aspects of science
(v) to teach about the nature and methodology of science
(vi) to counter over-specialisation

Sherratt also mentioned Cawthorne, a science teacher of the 1930's, who advocated that the student should project him or herself into the life of the scientist and thus see the historical facts "within a wider context of their contemporary intellectual and social background". The biographical details of scientist and a chronological statement of the scientist's work was not considered adequate history by Cawthorne.

Sanchez (1989) in his paper presented in 1989 at the major Florida State University Conference on the History and Philosophy of Science in Science Training, supported this viewpoint and suggested that it is important that students recreate and re-live the problematic situation that led historically to the revision of belief and understanding.

Sanchez suggested that the use of historical material may be 'implicit', that is, no mention need be made of historical names, places and dates but the teacher may introduce counter-arguments and new problem situations from which the student develops a new and better model.

With regard to the nature and methodologies of science, Sherratt (op cit) supported the arguments for pupils to understand the nature of scientific method and the consequent transient nature of scientific laws and theories. Overall it was recommended that science should be presented as a method and not merely as a collection of 'facts' and it was suggested that the history of science may often provide suitable material for the achievement of such a goal.

In his paper Sanchez (op cit) also noted that the inclusion of the history of science may change the sequence in which material is presented. He argued that there is no inherent reason that the organisation of the subject matter by an expert in the discipline is necessarily the best way for a novice to first experience the material. The learner's task may
better be seen as confronting his or her own ideas and models with those which have a more general acceptance.

Kenealy (1989) highlighted the importance of coherence in the outline of scientific material - he pointed out the apparent comfort the human mind takes in a coherent set of ideas even when 'wrong and scientifically unsound'. He saw historical material as offering the potential for developing such a coherence.

At the same 1989 Florida conference Lochhead and Dufresne (1989) advocated the use of 'historical dialogues' between, say, Aristotle and Galileo or Newton as a way of improving student comprehension. In another paper at this conference Solomon (1989) presented the possibility of utilising classroom drama in a 'Retrial of Galileo'. Solomon suggested that this might illustrate the difficulties of 'overturning' an old theory which has become a part of a society's way of thinking.

If the students learn about the historical models as well as the currently accepted model they may better see how the current theories more adequately explain the data. This benefit is only likely to result if the students are able to think from alternative perspectives. They need to go beyond the models and theories and discuss the arguments in favour of them. The historical material in the CXC syllabus may, therefore, be seen to have several uses including the following:

(a) The development of scientific methodology and attitude can be well exemplified by aspects of the work of Galileo, Newton, Faraday and Curie.
(b) The tentative nature of scientific theories may be demonstrated with reference to the changes in scientific understanding that have occurred. Students have a tendency to believe in some absolute scientific truth which is a misrepresentation of the nature of science.

(c) There is now much research (in what might be called a 'constructivist' tradition) that suggests that the conceptions that children possess prior to instruction, and bring to their science classes, have at least some, and often quite considerable, resemblance to historical scientific models.

As an example of this latter point it is worth noting that research evidence suggests that Aristotle still maintains a considerable number of followers. For example, Vinnent (1979) working in France, Belgium and Britain found widespread occurrence of alternative conceptions which were very resistant to instruction and had many similarities to Aristotle's ideas.


Although no substantial work on this topic has been conducted here in the Caribbean, work has now started (Whiteley, 1991). Also, the reports from the CXC examiners (CXC, 1985-91) have, on three occasions, highlighted the prevalence of Aristotelian or quasi-Aristotelian views in the candidate population for the CXC physics examination.

However, the decision to include historical material in the CXC physics syllabus has been resisted by physics teachers in the Caribbean. The teachers seem to have been generally

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ICASE AWARD SCHEME

for outstanding contributions to international science education

Nominations for these awards must be forwarded by member associations of ICASE. For full details of how to forward nominations, contact the Executive Secretary below.

ICASE Distinguished Service Award

This award is made to individuals who have a career history of distinguished service to international science education through their involvement in the international activities of local, regional and global science education organisations.

ICASE Regional Service Award

This award honours individuals who have made a significant contribution to international science education through their involvement in international activities at the local and regional levels.

ICASE Association Award

This award recognises individuals who, within their science teacher association, have made a significant contribution to the international activity of their association.

Contact Dr Jack Holbrook, Executive Secretary ICASE
Department of Curriculum Studies, University of Hong Kong, Hong Kong
unfamiliar with the older, alternative models, the growth and development of science and scientific methodology and the nature of scientific advance. The CXC/USAID Secondary Curriculum Development project was the source of a useful booklet for teachers, "History of Physics" (Stahl, 1983); other sources of information are available but the attitude of teachers appears to remain largely negative. The teachers seem to need greater support to develop ways of utilising the historical material to help improve their students' conceptual understanding. Strategies might be outlined in which the material could help to provide a context within which students could debate the pros and cons of alternative ideas. In the case of the Aristotle/Newton paradigm shift most of the better arguments on the Newtonian side are far from direct observation and involve the extension of ideas and experimental results to a non-observable limit - as Galileo did when imagining situations with no friction. Further, the historical development of concepts may even help teachers to predict students' preconceptions and thus be better able to take the students' ideas into account while teaching - see, for example, Wandersee (1985).

Conclusion
In this article the development of the Caribbean Examinations Council physics syllabus has been outlined and the introduction of historical material noted. A variety of possible reasons for this inclusion have been mentioned. It has been suggested that parallels between student ideas and previously accepted models may advise the use of the historical material to help students clarify and change their own beliefs. The resistance of Caribbean physics teachers to the introduction of this material has been mentioned and it has been suggested that the teachers need greater support in order to better utilise the new material.

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About the Author
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Research Rookies
A Highly Successful Industry-Education Liaison Program

by

Henry DePhillips
Kenneth Russell Roy
Elizabeth S Shamroth

The National Commission on Education in its NATION AT RISK report of the early 1980s, served to alarm the United States that its public education system was in trouble. Since the advent of that report, over 250 additional national reports have been issued sounding similar concerns and recommendations to improve the educational system in the United States.

As a result, the United States has committed itself to making the 1990s the ‘education decade’. If improvement of education in the nation is to be effective, it must take place at the ‘grassroots’ level of operation - the classrooms of its schools. It must touch every child to impact on the future of the country. One area of focus on this complex and difficult issue is the need to improve the science education learning experience for its students. Student learning must go beyond the reading about science. It must include the doing of science, its processes and its relevance. By the year 2000, 85% of the available science and technology jobs in the country will need to be filled by women and minorities. Additional sectors of industry report similar shortages and concerns. Business and industry want graduates to: communicate, think and problem solve, negotiate and work within a team, read, write and compute. It has been seen as a time to move beyond the rhetoric of the reforms - the reports of the 1980s.

One school district of 5000 students saw and chose to address this need directly. The Glastonbury Public Schools district in Glastonbury, Connecticut, USA responded by developing several mentorship programs with local businesses and industries. The programs are a novel and exciting way for the business and industrial communities to become involved with students in grades 7-12. As part of their mentorship course work, students are exposed to real work experience programs in a variety of science/technology oriented businesses and industries. It is an opportunity for members of the working community in partnership with schools to help influence a student’s life in an exciting and highly motivating way. It is this component of the program which provides a high level of relevance to the subject being studied and the world of work in general. The program fosters career development, interpersonal skills, written and communication skills and knowledge-based growth.

How it all started
In a technological and information oriented climate, the influence of science is all encompassing. There was a definite need for students, especially those in science classes, to learn not only what scientists do, but also how they think. Having an opportunity to engage in a research project under the tutelage of a working scientist and/or technologist would provide a unique learning experience for students. The necessity to encourage students to commit themselves to scientific/technological careers and to provide them with opportunities to experience practical applications related to their classroom studies was also paramount. Finally, there was a need for a program which would help them to develop an enhanced sense of responsibility, build a positive work ethic and gain skill in adult interactions in a work based situation.

Given these needs, the Glastonbury mentorship model was initiated by a science teacher and a K-12 science supervisor, with the support of the high school principal. The science teacher and supervisor developed the basic mentorship model. The mechanics of the program were worked out by formulating a rationale and considering schedules, sites, transportation and credit, as well as responsibilities of students, the faculty advisor and the mentor.

The Mentorship Program
In 1988-89, the program was piloted for one semester. Twelve 11th and 12th grade students in a high achievement level biological science course participated in the project. They received classroom instruction in the principles of biological science and research until the middle of October. From mid October until mid December, a total of about seven weeks, the mentorship component of the course was implemented. During that period, on an average of two afternoons per week, students continued to receive in-school instruction for periods of 50 minutes per class. Three additional afternoons during the week, students left school at 11.30 am and went to their mentor establishment. There, they worked on-site for a minimum of 100 minutes per session. Since the class was scheduled during the last two periods of the day, hours away from school did not cause time to be lost from other courses. Also, this scheduling allowed for greater flexibility if there was a desire on the part of a student and his/her designated mentor to extend the on-site hours.

Prior to September, the teacher and supervisor secured the involvement of business and industry mentors for the program. Personal contacts known to the teacher and supervisor, telephone calls to individuals actively involved in
research activities, mentor recommendations involving other colleagues, student contacts and general referrals made by personnel officers were successful in developing a pool of opportunity for students. Once school began, the teacher/advisor worked with the students in the program to select appropriate research projects and methods. Students were paired with mentors based upon interest and need relative to their research projects. The mentor and teacher jointly planned and implemented a program for the student. The research mentor then worked with the student to help guide the development of the project. The teacher/advisor interacted with the sponsoring business or industry on a regular basis to monitor student progress and evaluate results. Professional release time was scheduled for the teacher to visit mentors at the job site.

Implementation of the Program

Once the student selected a project, the mentor was contacted and background references and readings were assigned. It was important that each project be within the capability of a novice scientist, but that it contain sufficient challenge so that the student would experience the real flavour of a research environment. Two approaches were tried and they were equally successful. Some students were incorporated into an on-going investigation which had one or more components that could be completed within a reasonable time and which would yield some definable result(s). Others selected self-contained studies in which specific objectives could be chosen. The common denominator in each mode was the opportunity to work independently, after proper instruction and supervision, so that the students acquired both the skill for good lab technique, as well as the confidence that the results obtained were reliable and accurate.

An example of a project in which a student participated in an on-going investigation was an analysis of the amount of a foreign metal ion incorporated into a respiratory protein before and after removal of the native metal from the active site. A self-contained project which students completed was an analysis of the mineral content of over-the-counter vitamin and mineral supplements to check for label accuracy and brand reliability.

The initial training sessions were the most labor intensive, requiring one-on-one discussion, examples and tracking of the steps leading to good experimental technique. None of

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9
the students in the program had any prior exposure to a business or industrial research lab and each evidenced the timidity of entering a new and somewhat overwhelming arena. One approach that helped to reduce this anxiety was to provide students with their own (small) desk space, a place where they could go to write up results, read references, plan the next series of experiments and keep notebook and papers. The transition to an operating laboratory was made quickly because these students were not only bright, but also very enthusiastic about undertaking this experience.

Upon completion of the projects, the students wrote a research report submitted to both the mentor and the high school science teacher. Each then rated the student’s performance and the teacher assigned a grade. In addition, students were required to prepare and deliver a 15-20 minute presentation to their classmates which described the nature of their research experience.

An important component of the program was to let students see first hand that what is taught as supported fact is often based on imperfect and, in some cases, imprecise data. The primary function of the mentor was to ensure that the transition from class/lab mentality to a research environment was seen by the students as the next logical step in their science education. In our experience, the main reason why this partnership works is because of the time commitment made by the mentor. This time commitment is necessary to train the students in the methodologies they will use in their studies. It is important that they be well versed in the instrumentation used for their study and be encouraged to have confidence in their results.

Assessment and Outcomes

Upon completion of the course, different evaluation instruments were distributed to students and mentors. A series of questions and value judgements were asked and they were ranked on a Likert scale. In addition, an opportunity for comments about the operation of the program was provided at the end. The outcomes were stellar. Both mentors and students were enthusiastically supportive of the program and their only regret was that there wasn’t more time available for it. With this in mind, the Board of Education decided to increase the Biological Science Mentorship to a full year beginning in September 1989.

The Biological Sciences Mentorship is now in its third year. There continues to be a high level of enthusiasm and support for it among the mentors, students and in the community at large.

The mentorship program provides students with opportunities to apply and build upon their knowledge and skills secured in the formal academic setting of the classroom. It also allows them to explore working with adults and to develop adult role models. It truly is an opportunity for committed partners in business and industry to help influence a student’s life with particular attention to career development, work ethics and adult interaction. Research rookies are key to turning national report rhetoric into effective education.

Program Expansion

Given the success of the program in meeting its goals, the program has been expanded. A second course was developed in an alternating year schedule with the RESEARCH MENTORSHIPS IN THE BIOLOGICAL SCIENCE course. The new course titled RESEARCH MENTORSHIPS IN THE PHYSICAL/ EARTH SPACE SCIENCES course has offered additional research opportunities.

At the middle school level (grades 7 & 8), motivated students may elect to attend a semester research course one to two days a week after school in addition to their regular science class. Beside the classroom time, for two or more hours a week, the students work with mentors from the business/research community. The research projects are smaller in scope compared to the high school level but they allow the students initial exploratory research with professionals in the field.

In grades nine and ten, a seminar course has been developed. Students meet at the school in a seminar format with mentors from business and industry to focus on the components of a project as a process. Scientific process skills are an integral part of their area of study.

Conclusion

In their three years of operation, the 7-12 mentorship programs have provided the school district with over US$1,000,000 of in-kind consultant time. More importantly, students are gaining a new insight into what doing science is all about and who the people are that make it happen.

Additional information on the program is available by contacting Dr Ken Roy or Mrs Elizabeth Shamroth, c/o Glastonbury Public Schools, Glastonbury CT 06033, USA.

References


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ISY
International Space Year
1992

500 years ago, Christopher Columbus sailed three small craft – the Nina, the Pinta and the Santa Maria – across the blue Atlantic Ocean of our planet to discover a new world. 35 years ago, Russian technologists suprised the world by launching Sputnik into the heavens beyond this Earth's atmosphere.

ISY, in a unique display of international collaboration, celebrates these historic achievements and initiates new ones. It promotes worldwide cooperation in space, addressing environmental issues of global concern, and increasing awareness of the economic benefits of space science and technology.

ICASE and ISY

The ICASE contribution to ISY is through two international projects:

Resource Materials for Science Teachers

Dr David Moore, ISY Project Officer for ICASE, is coordinating the production of a set of resource materials for teachers, in collaboration with the ICSU Committee on Teaching of Science. For further information, contact:

Dr David Moore
ISY Project Officer, ICASE
ASE Headquarters, College Lane
Hatfield, Herts AL10 9AA, UK

ICASE World Activity Day

Thursday 14 October 92
Theme for 1992: Space

Teachers and students in schools around the world are invited to participate in special activities focusing on the theme of space. Thursday 14 October 1992 is designated as ICASE World Activity Day. Member associations of ICASE are requested to encourage schools in their countries to share in this worldwide program on 14 October. The activities, which can be adapted to suit students at all primary and secondary levels, include: (1) Designing, constructing and testing rockets which operate on compressed air and water; (2) Calculating the Earth's diameter by measuring the length of the shadow cast by a stick; and (3) Writing a short essay (maximum 1000 words) on (a) space travel in the year 2092 or (b) life as a student in 2092 as a result of space technology.

See this issue for an outline of these activities. For further information, contact: Brenton Honeyman, ICASE Journal Editor, 10 Hawken Street, Monash ACT 2904, Australia.
Report on the Sixth International Symposium of IOSTE

by Joan Solomon, Oxford University Department of Educational Studies

This article is reprinted from The British Council's Science Education Newsletter 100, January 1992.

IOSTE (the International Organisation of Science and Technology Education) is a non-bureaucratic association of individuals from many countries who are interested in promoting science and technology education. It runs international symposia, and keeps its members in contact through occasional newsletters.

The venue for the sixth symposium in August 1991 was Palm Springs, USA. There were some 200 participants from 25 countries. The ideas we hatched will be quite enough to keep us busy in our separate countries until the 1994 symposium in Einthoven, Holland.

It would be impossible to describe all 30 sessions in the space of this article. I shall concentrate on four talks I found the most inspiring, important and imaginative innovations for science education.

The first talk was by Basil Jones and Adrian Kohler, two young men who were travelling through the USA gathering ideas for their television project which will use glove puppet characters to teach primary science concepts in black community townships of South Africa. They told us that although only 27% of homes have television, each set is watched by many children. They plan a series in which topics such as light and forces are explored by a group of children (four black and two white), without a teacher, all of whom have characters and different misconceptions. The idea of using cartoon 'thought bubbles' to illustrate the operation and change in the children's ideas was inspired. There will also be simple investigations using non-laboratory equipment. The last 10 minutes of each program will be devoted to a guest star -- a local sports hero or a scientist -- who will set a problem for the viewers to think about. The solution will be given at the beginning of the next program.

The second talk was quite different. It was concerned with teachers rather than directly with students, concentrating on finding good strategies for new technology in the classroom, and was presented by Maria Saez of the University of Valladolid, Spain. The question that this country faces, like many others, is how to get the maximum advantage out of the very limited numbers of computers and video players available for science lessons.

The research was carried out in an appropriate and interesting way, not by university lecturers but by teams of practising teachers carrying out the new strategies in their classrooms. The two lecturers were there to encourage the team of teachers, help them to develop research skills, and to organise and analyse the data produced so that it could lead to a holistic understanding of the teaching/learning process.

Finally, and perhaps most importantly, they supported the teachers in a kind of auto-evaluation of their experiences. While researchers in richer countries often bemoan the non-implementation of their research, this kind of investigation-on-the-job can and does lead to changes in lesson strategies brought about by the teacher-researchers as they explore and evaluate their work.

The third session was also extremely interesting; it was given by two Brazilian educators. At first I sat quietly listening, with only half a dozen others (the session was timetabled against a far more popular session by a Western educator), to the account of a well designed program of environmental and health education which probed children's notions of health, developed INSET courses for teachers, created new instructional materials, and encouraged children to use hygienic practices in order to lessen the likelihood of catching parasitic diseases.

These diseases include schistosomiasis, an infection of the liver that is endemic in some parts of the world, affecting between 8 and 10 million people in Brazil alone. Almost without being aware of the transition I found myself listening to a story of how this young associate researcher from Rio de Janeiro, Virginia Schall, had discovered a plant, Euphorbia splendens, whose latex is toxic to just those snails that carry the parasite. It seems that one part per billion of the active ingredient is lethal to the snails. This is a most
Physics Teaching: A Publication of the Chinese Physical Society

by Prof Mi Zihong
Department of Physics, East China Normal University, Shanghai 200062, China

Physics Teaching is one of the periodicals published by the Chinese Physical Society. Its Editorial Board consists of thirty four experienced university professors and high school teachers across the country. In addition, there is a Correspondent Team consisting of seventy eight government education officials in provinces and cities throughout the country. The journal is published monthly in Chinese, but with English subjects. An English version is now being published.

The Journal has a history of more than thirty years; the current name Physics Teaching was adopted in 1978. As a monthly periodical, the Journal aims to reform physics teaching, to exchange teaching experiences, to report new important discoveries in physics, and to introduce what is happening in physics education in foreign countries. Special columns include Teaching Research, Teaching Abroad, Questions Assigned and Solved, Physics Window, Teaching Jottings, Experiment Sidelights, Teaching Material, and Physics in Daily Life.

The Journal’s readers (and authors) are physics instructors and students in universities and in senior and junior middle schools. Libraries in most schools subscribe to newspapers and periodicals, hence, assuming that there is an average of 100 readers in each school, the number of people reading the Journal may be more than 4 million!

In order to promote countrywide research in senior and junior middle school physics and to strengthen teaching through exchange of experience, the Journal has convened occasional conferences. These have included the National Conference for Special Classification Teachers of Middle School Physics; the National Conference on Micro-Computer Aided Physics Teaching; the National Conference on Educational Theory and Practice; and Seminars on Natural Science Teaching in Shanghai and Hong Kong.

The Journal jointly publishes physics books such as Eight Lectures on Senior Middle School Physics and International Physics Olympiads which have proven to exert considerable influence in China.

Towards a European Curriculum: Implications for Science Education

A Report on the 1991 ASE Assessment Seminar

by Drs Jan Hendriks
European Representative
ICASE
The Netherlands

Approximately 80 delegates participated in the 1991 Assessment Seminar of the Association for Science Education, held in November 1991 at the University of York, UK.

The first of these events in 1988 aimed at promoting discussion of significant trends and issues in assessment, involving an invited delegation drawn from a variety of backgrounds and with varying experiences and perspectives. The 1991 seminar focused on looking forward in the European context.

In the European Community, there will be open migration; all certificates and examination results will need to be acceptable to all EC countries. Hence it is critical to exchange information about the educational situation between countries.

The ASE invited four representatives from the continent to describe the educational systems of their countries, and the Headmaster of the European School in Culham, Prof Hans Vonk, Free University in Amsterdam, spoke about what was happening at primary and secondary levels up to tertiary level admission in The Netherlands. Ms Nicole Herman, Lycée Roosevelt, Reims, shared interesting developments in primary and secondary education in France. Mr Jan Thorsten from the University of Oslo spoke about the situation in Norway. Prof Hans-Jurgen Schmidt from the University of Dortmund presented an overview of tertiary education in Germany. Mr T Hoyem, Headmaster of the European School in Culham, described the European School where pupils from different countries with various needs, meet each other in the one school.

Prof Jeff Thompson from the University of Bath, UK presented a
summary of the Seminar. One conclusion of the lectures and discussions was that there are significant differences in curricula and examinations not just between countries but, as in the case of Germany, also within some countries. There is a case for a common core curriculum - but who should decide? Is there are role for ICASE in this?

Bob Fairbrother chaired the meeting, which was organised by Colette Baird, Assistant Secretary of ASE. The Association for Science Education is to be congratulated for convening this important Seminar.

National Science Policy Making Body in Cameroon
by Kiteh, Augustin
GHS Nkambe
North West Province
Cameroon, West Africa

According to Unesco (1966), the correlation between economic development and science and technology is so high that one definition of a less developed country is simply 'a country without science and technology'. Science and technology education can contribute directly to a country's primary health and nutritional care, effective population control, and development of human resources for agriculture and industrial activities (Unesco 1981). It is realised nowadays that science and technology has a profound influence on the 'change' component of development (Unesco 1986). Science and technology education, suitably designed, is an inseparable component of a country's development effort.

The main problem in Cameroon has been to identify practical ways in which to structure education for science and technology so that its contribution to sustainable development is maximised. The successful

The Second International Conference on the History and Philosophy of Science and Science Teaching

The Second International Conference on the History and Philosophy of Science and Science Teaching follows and builds on the very successful first conference, funded by the National Science Foundation. It was held at the Florida State University in Tallahassee, Florida, USA in November 1989, and attracted 300 people from 20 countries. The second conference, to be held at Queen's University in Kingston, Ontario, Canada during May 11-15, 1992 will host 400 science teachers (including elementary science teachers), science teacher educators, educational policy makers, scientists, and historians and philosophers of science from more than 20 countries.

This conference will provide the second opportunity for members of these professional groups to meet and collaborate in investigating ways in which the history and philosophy of science has, and can contribute to the preparation of science teachers, the development of curricula, the enhancement of science education, and the development of a more scientifically literate community by making science and technology more accessible and attractive to young people.

The first conference focused on science teaching in the high school. For the 1992 meeting, the focus has been broadened to include science in the elementary school. David Hawkins, well known for his work not only in the history and philosophy of science but also in the development of elementary science curriculum (he is a former Director of the Elementary Science Study ESS), is Honorary Conference Chairperson.

The themes of the second conference, designed to build on the achievements of the first, include:

- Science, Technology and Society
- Curriculum Reform and Teacher Education
- Science Education and the Environment
- Scientific Literacy
- Exemplary Practice in Science Education and Science Teacher Education
- Values and Science Education
- Women in Science

Conference sessions will also incorporate exemplary practice, lesson materials, curricula and research results from many different countries.

A number of distinguished writers have been asked to prepare papers exploring these themes, and to facilitate collaboration between participants in interdisciplinary groups.

In addition to the invited papers, a parallel program of contributed papers will enable science educators, historians of science and philosophers of science to contribute to the program.

To maximise involvement and discussion among participants, papers will be published in journals and proceedings, and distributed prior to the conference.

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For information about other conferences refer to the section Calendar in this issue
exploitation and assimilation of scientific and technical developments can only proceed with the support of interested and informed politicians and administrators in the Ministry of National Education in Cameroon. The responsibility for fostering this interest should rest with the Ministry of National Education.

It is critical that administrators within the Ministry of National Education have some understanding of the role that science and technology can play; however many administrators are not scientifically literate, nor are they critically aware of science related issues. They lack sufficient understanding about science and technology education, and therefore are unable to take up effective action relating to it.

With this as background, Cameroon would benefit from the setting up of a national science and technology policy making body such as an association for science education. Such a body could formulate national policy for science and technology education relevant to defined sustainable development objectives. The body could act in a unifying role to direct the efforts of local teacher groups working towards curriculum solutions.

The economic, social and cultural situation in Cameroon will clearly impact upon the objectives and resources of such a policy making body. Science and technology will play an important role in the socio-economic development of the country; Cameroon needs a clearly defined national science and technology policy aimed at systematically integrating science and technology into the formulation of objectives of national development plans. A significant index of Cameroon’s technological development is the country’s ability to use local technological capacity to produce local science equipment needs (that is, in the tools and instruments used, and in how knowledge is applied to the production process). Educational technology needs to be developed in close collaboration with those who are to use it. It must be capable of being built and maintained in the Cameroon itself. Even simple and inexpensive equipment can be intellectually powerful.

The absence of a national science policy making body in Cameroon hinders the formulation of a coherent national scientific and technological development plan. Such a body need not operate in isolation, but could link with other organisations such as the Association for Science Education in the UK or the International Council of Associations for Science Education (ICASE). This would provide essential exchange of ideas and experiences; dissemination of information about new materials, resources and systems; and the opportunity for Cameroon to obtain assistance in developing a new approach to science and technology education.

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Unesco (1966) An Asian Model for Education Development
Unesco (1986) Comparative Study on the National Science and Technology Policy Making Bodies in the Countries of West Africa

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Teacher Self Evaluation

by John Penick
Science Education Center
University of Iowa, USA

Without evaluation, we improve only randomly, a process which might as easily cause regression. In evaluating, we compare actual outcomes to predict, examine progress towards goals, or analyze appropriateness of action. All competent professionals self-evaluate while performing their tasks (formative evaluation) as well as after task completion (summative evaluation). Without formative evaluation, we have to wait until it's too late to see if our process is appropriate. Without summative evaluation, we never reflect back on quality or whether the task was even necessary. In addition, competent professionals must evaluate continuously. A brain surgeon can't just take a peek occasionally to see if all is as expected. Teachers are not different; as teachers, we must continually self-evaluate. What question should I ask next? How should (or did) I respond? How well do they understand? Why doesn't Johnny pay attention? Am I doing the right thing? Teachers, like all professionals, self-evaluate. In fact, many would say that serious self-evaluation is what differentiates a true professional from other occupations. As teachers, our ability to self-evaluate allows our teaching and effectiveness to evolve to its fullest. Without it, we are doomed to mediocrity or worse.

While all teachers evaluate their teaching to some extent, the very best teachers have learned to observe consciously their teaching systematically and compare those observations to what they would like to see. Some people call this 'comparing the desired state to the actual'. Call it what you will; before you can see something, you must know and remember to look for it. A checklist such as this makes it easier and more systematic.

The checklist at the end of the article is based on goals and ideas from teachers in Portugal, Taiwan, Singapore, Russia, Puerto Rico and the United States. It reflects their understanding of their role, their needs of their students and their knowledge about the research literature. Their typical interest in being professional prompted the final section on "My Professional Attitude". While you can use the checklist without much elaboration, for those of you interested I want to provide a brief rationale and some of the research support for each item. And, by reading this part, you will learn some of the subtleties of each item as well as potential consequences of use or non-use of each.

About My Teaching

Rather than evaluating teachers based on student scores, most educators feel that the teaching comes first. Some students learn better than we do and others do well to learn anything positive. No matter, you can still look at your teaching to see if what you are doing should lead toward your goals. Of course, this implies you have overt goals. For this checklist, the stated goals for students were that they:

- Identify and solve problems
- Be self-motivated
- Be confident and independent
- Communicate effectively
- Apply science and knowledge
- Know how to learn
- Be creative
- View science as a way of knowing

With these goals, looking at the research literature allows you to determine the key elements in achieving them. Obviously, if you aren't working toward these particular goals, this checklist may not be appropriate for you. If so, modify it to better reflect your own goals.

Have I maximized intellectual freedom?

Percy Bridgemen, a Nobel Laureate in Physics, said "Science is doing your damndest with your mind, no holds barred". Richard Feynman, another Nobel Laureate in Physics, said "Science is a belief in the ignorance of experts". They both recognised that science is a search for evidence, patterns, ideas, and explanations. For a student to feel free to do science, they must have intellectual freedom, something very different from social freedom. While students can't just come and go as they please, if they can't think freely they will not be learning science as it is known to scientists. Intellectual freedom is increased by:

1. Asking questions which require more than memorised answers

While memory is certainly important, few other than idiot savants earn their living by demonstrating their memory. Truly successful adults use their knowledge, demonstrating
understanding. A continuous series of questions guides the most successful, whether a golfer asking "How should I hit the Ball?" to a surgeon asking "What will happen if I cut here?" And, besides, science is the land of questions as well as answers. Answers in science are temporary, based on what we know today with today's technology. With new questions we will surely have new answers tomorrow. Why memorise yesterday's information when tomorrow is just a few hours away?

2. Waiting sufficient time for responses

Consistently, research has informed us that teachers often wait only a second or two after asking a question before they answer it themselves, rephrase it, or direct it to another student. What kind of answer can a student formulate in two seconds? How long does it take to make up an answer for "How would you find out which coat insulates best?" Would you go out for a coffee a second time with an adult who asked YOU questions and waited only a second for a response? In addition, that same research indicates teachers actually give more time to the brightest students and the least time to the slow ones!

3. Seeking multiple response from students

With creativity as one goal and the tentative nature of science in mind, we always seek to get a variety of answers. This reduces the risk for students and increases the possibility that a given student will get to respond. At the same time, the slower students have more time to think of answers and all get to build on prior ideas. And, ideas are what we thrive on in science classes where intellectual freedom is the norm.

4. Accepting (rather than evaluating) responses

Research on thinking is clear; if you want students to produce a variety of responses you must not evaluate ideas as they are produced. First, ask a good question then wait. If you accept student responses by nodding, saying "OK", "alright", writing the response on the board, or in some other way indicating you have heard and accepted, more wait-time will prod other students into saying more. A very active teacher, one who stimulates students to think, will find that the combination of the right stimulus idea or question, good wait-time, and acceptance usually produces ten or more ideas. The Evaluation section (below) offers some ideas on how to appropriately judge the worth of the numerous responses.

5. Using student ideas in questions and statements

When someone used your idea they encourage you to do more. A teacher's use of your idea goes even further, giving legitimacy to both you and your thoughts. You can use student ideas by writing them on the board, asking a question about the idea ("OK, Lucas, if water could freeze at 75 degrees, what might happen to our cities?") or by asking the student to clarify ("Megan, what do you mean by 'synthesize'?"). This is exactly what we do in good adult conversation. Two adults conversing pick up the ideas of others and use them for the next statement. Most statements are linked and relate to each other. This is why we find good conversation stimulating and the time passes so quickly; our ideas are part of the conversation. We are both involved and necessary. Make student ideas a necessary part of the classroom conversation and they'll be more involved.

6. Evaluate responses based on consequences

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Dr Jack Holbrook
Executive Secretary
Department of Curriculum Studies
University of Hong Kong
Hong Kong

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**Eighth ICASE Asian Symposium**

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**Science Education for a Changing World**

Contact:
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Ideas are rarely inherently right or wrong. The true evaluation of an idea lies in its usefulness. If a student suggests making a better clay boat by mixing water with the clay, it’s easy for the teacher to save the student time by saying “Water will make the clay soft, it won’t work as well”. When the teacher evaluates for them, students lose all opportunity to evaluate for themselves and may well become dependent on the teacher. And, equally important, you, the teacher, may be wrong. How do you know the student is not on to something? Remember, “Science is a belief in the ignorance of experts.” Let the student try and see the consequence of his idea. This is a true evaluation.

If you have asked for ways to improve the city water treatment plant and make it look better, and the students have generated a long list (probably including “paint it purple”, “have snakes all around”, and “put a heavy metal rock group on the roof”) evaluation can also come from the students. An effective technique is to have students, in small groups, select five or six ideas that seem best or most possible right now. This usually eliminates the ‘fun’ responses. Now, you can have various small groups compare their lists, seeking to reconcile their differences. You can also ask them to rank order their ideas. From here, it’s a natural step to have them plan to bring about the changes. To be successful both students and teacher must learn to self-evaluate.

7. Have high expectations for all students
Research, over and over again, indicates a subtle pattern of classroom bias. Teachers give more encouragement, smiles, nods, time, and expect more of students perceived as being of high ability. Boys are rewarded for how well things work while girls are rewarded for how they look. High ability students get praise for academic efforts while those of low ability get praise for other activities. While it’s true that high ability students do usually perform better, evidence indicates students are aware of your expectations. This doesn’t mean you should have unrealistic expectations; just make sure you communicate to students that you have high expectations for each and every one of them and for yourself.

8. Model the goals and behaviours you expect of your students
Have you ever watched children playing “school”. What kind of teacher do they play? Why are they always authoritarian teachers? Are they modelling themselves after you? Many studies demonstrate that students copy their teachers’ behaviour. We even see this with our own children. If you want students to ask good, thought-provoking questions, then you must do the same. So, you also need to be seen as inquisitive, open, accepting, and communicative, indicating that you are a learner also. A
coach does not have to be better than the player and you don't have to be the all-knowing, super competent science star. Instead, you must indicate interest, understanding, and a desire for success, while helping students analyze, question, reflect and proceed.

9. Be consistent
Your pattern of behaviours tells much about you and a consistent pattern allows students to be more comfortable with you. They know what to expect. And, since students do pay attention to you, your pattern will become a model for students. For example, if you consistently approach new situations with questions, experiments, and a variety of ideas, your students will do the same. Research even indicates that teachers who dominate students have students who act domineering. What kind do you want to live with?

Are students doing science?
"Doing science" means far more than watching a demonstration, listening to a lecture, seeing a film, or even doing an activity. Learning requires action and the action must be both physical and mental. During a demonstration, students are passive, watching and listening and maybe even thinking. But, the real science comes when they go beyond the demonstration, seeking explanations, working with the materials and doing it themselves, modifying the demonstration. Science is doing and thinking, not just watching and listening. Even when doing an activity, if they follow explicit directions or have limited equipment, students may be able to "do" without any real involvement. Effective teachers continually ask themselves "Right now, are my students doing science?"

Are students applying their knowledge?
"What is knowledge if not applied?" We know well that we learn best when we use as we learn. Would you fly with a pilot whose training consisted of a series of lectures and films on flying? Applying what you know also causes you to learn more as you find you lack certain information or ideas. In the 1986 United States National Assessment of Educational Progress in Science, students who scored the highest on the content items reported applying science more than did lower scoring students. Students apply sciences when they construct devices, plan experiments, or even when they seek information from others. The key is that they are learning, not for an exam, but to use knowledge.

My professional attitude
1. Do I belong to a science teacher professional organisation?
Although you might be an excellent teacher, professionals have added responsibility in improving their profession by communicating with peers. Novice teachers attend meetings hoping to gain new knowledge. Experienced teachers must be there to provide it. Professional organisations speak for members and must have broad input to be truly representative. New initiatives undertaken must be staffed by competent professionals. An outstanding teacher is a professional who takes professional responsibilities.

2. Do I read two or more professional journals each month?
Journals are a profession's way of communicating with members. If you don't read them, their messages die quickly. Journals are also an easy way to stay current on events, topics, and happenings. In a recent study of teachers in exemplary programs, Dr Ronald Bonnsette (who edits the Science Teacher Education section) found that they read an average of two professional journals each month.

3. Have I voluntarily attended recent meetings or inservice for science?
Dr Eddy Hidayat of Indonesia, in a study of the best and worst science teachers in a number of United States districts, found that the best were eleven times more likely to have attended a voluntary inservice during the prior year. Effective teachers attend inservice, not to be totally enlightened, but to glean a few new ideas or reinforce an old one or two. They know that not all will be great but that most have something to offer a creative and analytical teacher.

4. Do I present my ideas at such meetings?
As professionals we have obligations to communicate our ideas with colleagues. Bonnsette's study found that most teachers in exemplary programs had presented sessions at inservice meetings. And, since you know well that you learn more when you teach than do in taking a class, these are teachers who are learning it even better.

5. Have I published any of my ideas or findings?
Publishing, though not expected of teachers, is the hallmark of the scholar. Why shouldn't a teacher be a scholar? Plus, if you really have worthwhile ideas, shouldn't they be disseminated widely? Remember, a journal is the means of communication within an organisation. If you don't communicate then you are not taking a full role in your own profession.

6. Am I working on an advanced degree?
Even though degrees do not make competence, they are a mark of a learned person. To others, a graduate degree signifies that you care, expend effort, and know something. Since earning a graduate degree takes time and study, we can also assume you are dedicated and perhaps more current in your knowledge than someone without. And, truly exemplary teachers continue taking courses for credit, even if they finish the degree.

7. Do I audio or video tape and analyze myself regularly?
Yes, your administrator or colleagues can observe you. But, until you can self-evaluate, you are dependent on them. Unless you self-evaluate, you must wait for analysis until after they watch. But, a successful person evaluates continuously and continually. While audio tape may work, the best way is via video tape, observation, and very specific analysis. By watching for specific behaviours on the part of you and the students, you can learn that you, like all professionals, self-evaluate.

Some final thoughts
Can you imagine a serious and effective coach who did not analyse the game in progress and then, with the players, review the game later? If available, every coach would video
tape. And, rather than saying "Nice game!" or "Play harder, Lucas," coaches teach players to observe rather specifically and plan for the next time. "Lucas, what happens when you hold the ball like that?" Self-evaluation, done regularly and with serious deliberation, always leads to positive changes. To be truly effective, you must learn to observe clearly. Often, this means labelling certain behaviours and looking for nuance. You, like the good coach, should seek predictable and desired patterns of behaviour, trying out new ideas for improvement. Self-evaluation is more than a hearty, 

"I'm a good teacher!" Real self-evaluation is knowledgeable and based on evidence; "I'm a good teacher because I..." Using a checklist such as this one will give you that evidence and knowledge.

TEACHER SELF-EVALUATION

How Good Am I? Some Questions To Ask Myself

ABOUT MY TEACHING

Do I maximise intellectual freedom by:
• Asking questions which require more than memorised answers?
• Waiting sufficient time for responses?
• Seeking multiple responses from students?
• Accepting (rather than evaluating) responses?
• Do I use student ideas in my questions and statements?
• Do I evaluate student responses based on consequences?
• Are my expectations high for all students, regardless of gender or perceived ability?
• Do I model the goals and behaviours I expect of my students?
• Am I consistent in my behaviour?

ARE STUDENTS:

• Doing science?
• Discussing science with each other?
• Applying their knowledge?

MY PROFESSIONAL ATTITUDE

• Do I belong to science or math professional organisations?
• Do I read two or more professional journals each month?
• Have I voluntarily attended recent meetings or inservice devoted to math or science?
• Do I present my ideas at such meetings?
• Have I published any of my ideas or findings?
• Am I working on an advanced degree?
• Do I video tape and analyse myself regularly?
Reflective Writing to Enhance Communication and Learning

by Ronald J Bonnstetter

In recent years many preservice teacher preparation programs have increasingly requested students to write about their student teaching or practicum experiences. These daily logs, without guidelines, can be little more than a listing of happenings. However, with assistance, a journal can provide valuable insights for both the instructor and the student author. As instructors we are faced with increasing class sizes that make it progressively more difficult to maintain regular and personal communication with each student. A well designed journaling process can provide this one-on-one dialogue.

A Journaling Scheme

The following structured response guidelines are divided into three categories - Reaction, Relevance and Responsibility. This 3R Reaction scheme closely resembles Bloom's domains of learning taxonomy - the cognitive, the affective, and the psychomotor. The difference between the two nomenclature is that the 3R Reaction scheme deals with the reaction of the affective domain first, rather than the cognitive, as does Bloom. The rationale for the difference in placement is so the student can become aware of his or her affective response, and then deal with the cognitive merit of the learning regardless of the positive or negative affect associated with it.

When writing a 3R Reaction the following guidelines are suggested:

Reaction (Affective Domain, To Feel)

What was the reader's response (favourable, unfavourable, or mixed)? Give at least one example from the experience to support the point.

Relevance (Cognitive Domain, To Think)

How pertinent is the event to the issue at hand (the conceptual framework of the event)? The reader should be able to recognize and discuss how specific or important (meaningful) the event is to the course or issue and give at least one example from the reading to support the point.

Responsibility (Psychomotor Domain, To Do)

How will the knowledge gained from the event be used in the everyday life of the reader? Give at least one example of a possible application in your personal or professional life; simulate in behavior terms.

For the past three years I have collected student written logs each Monday. I have asked students to use the 3R Reaction scheme to help them become more reflective teachers. These entries vary in length from a half to two pages. By waiting until Monday the students are far more likely to include thoughts from Friday classes or student teaching and tend to be more reflective in their writing. The disadvantage of a Monday collection is that each journal must be read and written comments must be made by the instructor quickly.

STOP PRESS

New element discovered!

Following hard on the discovery of Administratium, announced in Vol 2 No 3 of Science Education International, comes news of another inert element – Unitednatium.

At first, because of the similarity in composition and structure, it was thought to be an isotope of Administratium. However, it has now been shown to be considerably heavier, with an atomic mass number estimated to be around 365. There is some doubt and the exact figure may even be 366; the matter is likely to be resolved in 1992.

The considerable gap in atomic mass between Administratium and Unitednatium is giving rise to speculation that there may be still other elements in the series. A well-known English lady politician and sometime chemist is rumoured to have identified one which has been tentatively named Eurocommissar by her friends.

Source: An anonymous ICASE Award Winner
so journals may be returned.

These written comments can be brief notes written in the margins or longer responses at the end of the student entry. Most instructors request that separate journal notebooks be maintained which contain no other material and that these future teachers plan to maintain their journals and revisit these written thoughts from time to time.

Without the 3R Reaction Scheme or some other form of guidance, many first time journal entries do little more than tell what happened. Instructor margin comments can be used to express the need for greater depth or elaboration. For example, "Yes, but how did this make you feel?" or "What would you do differently next time?"

If the instructor is serious about having students share feelings, then a non-threatening environment must be created. This simply means that the journal should not be used by the instructor to reprimand a student and written comments should not be dogmatic but suggestive. For example, instead of saying "You should have used grouping for this activity" suggest alternatives, "I wonder how grouping the students might have changed the outcomes?".

Journal grading must also be non-coercive if student openness is expected. Most literature suggests that instructors simply record the completion of journal entries and not make subjective and limiting judgements concerning entry quality.

This format has been particularly useful for the undergraduate preservice teachers who, for the most part, have never been asked to be reflective in their work. The 3R Reaction Scheme can also be used to add structure to article reviews; especially for those students who need help understanding the role of reflective writing. As is true of any teaching strategy, if over used its effectiveness diminishes.

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**Pasteur and Microbes**

**A Teacher Resource Book**

**Commemorating**

the 100th Year of the Pasteur Institute

1888-1988

This valuable resource book (166 pages) provides information about the activities and facilities available at the Pasteur Institute. It contains a variety of science experiments relating to the action of soil microbes, yeast as a food-making microbe, micro-organisms in milk, making cheese, making vinegar, and making wine, to name just a few.

These activities are appropriate for secondary science teaching. Emphasis is on useful micro-organisms, food production and food preservation.

Order by sending a cheque (payable to "ICASE") US$8.00 or £5.00 (add 25% postage and packing) to:

**Dennis Chisman**
Hon Treasurer ICASE
Knapp Hill, South Harting
Petersfield GU31 5LR, UK

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22
**Primary Science**

**STEPS**

The Stepping into Science Newsletter

The ICASE Project Stepping into Science is growing! On 3rd January, the Come and Share Workshop at the ASE Annual Meeting held at Sheffield University, UK attracted lively participation by delegates keen to learn of new activities for primary and elementary classrooms.

The second issue of STEPS (February 1992) includes several ideas presented at the workshop. One of them – The Texas Turkey Gobbler – is reproduced here.

A second ICASE Come and Share Workshop will take place at next year’s ASE Annual Meeting to be held at Loughborough University. Plan now to not only attend, but to bring along an activity to share.

For further information, contact Sue Dale Tunnicliffe, Project Officer, ICASE Stepping into Science Project, 18 Octavia, Bracknell, Berkshire RG12 7YZ, UK

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**TEXAS TURKEY GOBBLER**

*Based on the activity in STEPS*

The Newsletter of the Stepping into Science Project

**You will need:**
- paper cup
- toothpick
- paper towel 7.5 cm square
- thin string 45 cm long
- water

**What to do:**
Set up the items as shown in the diagram. Wet the paper towel.

What do you think will happen if you pull the paper towel along the string? Pull the paper towel along the string. What happens?

Some more for you to explore:
Try this activity using different types of string, different paper and plastic cups, and different types of paper instead of paper towel.
Does the paper towel have to be wet? Experiment to find out.

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**ICASE WORLD ACTIVITY DAY**

**14 OCTOBER 92**

Primary and Elementary Teachers are invited to involve their students in the worldwide activities celebrating International Space Year

See Pages 26-30
Moving on Air
Some Improvements

John Stringer, Project Director of SATIS 8-14, UK, has written to the Editor to suggest some improvements to the "Moving on Air" activity developed by the SATIS Project and published on page 30 of the September 1991 issue of this journal. The improvements he has suggested arose during the trialling of these activities.

The air track (pictured opposite) works better with a small piece of plasticene stuck to the ring to give it stability.

The hovercraft (pictured below) is more controllable if you stick a piece of tin foil across the hole in the wheel, and make a small pin hole in it. A clothes peg on the neck of the balloon acts as a brake until you are ready to start.

(Editor's Note: The activities opposite and below incorporate these suggestions.)

Moving on Air - The Air Track

From SATIS 8-14
Association for Science Education, UK

Make an air track with a plastic drink bottle, using a compass point or thumbtack to make holes as shown.

Make a 'vehicle' by cutting a plastic ring from another larger bottle. Make sure the ring has no ragged edges. Stick a small piece of plasticene on the bottom of the ring. This makes the vehicle more stable.

Moving on Air - The Balloon Hovercraft

From SATIS 8-14
Association for Science Education, UK

Make a model of a Balloon Hovercraft as shown in the opposite diagram.

The hovercraft is easier to control if you stick a piece of tin foil across the hole in the wheel, and make a small pin hole in it.

Blow up the balloon and see how it moves. A clothes peg on the neck of the balloon acts as a brake until you are ready to start.

Can you make your hovercraft bounce off things?

Can you improve on the design? Try making a hovercraft using different materials.

New Logo for Stepping into Science Project

Carolyn Petty of the USA, a member of the Stepping into Science Advisory Committee, has designed a new logo.

Activities Book

The Stepping into Science Project is planning to produce an Activities Book as a resource for primary/elementary teachers of science. If you have activities to contribute for publication in such a book, or in the Stepping into Science Newsletter, please forward to Sue Dale Tunnicliffe, 18 Octavia, Bracknell, Berkshire RG12 7YZ, UK.
Stepping into Science
An ICASE Primary/Elementary Science Project

AIMS

Stepping into Science is an ICASE project which aims to:

• Establish an international network for teachers to share ideas on the teaching of primary/elementary science and technology.
• Provide activities and support for teachers, thereby encouraging them to include more science in the primary/elementary curriculum.
• Promote the value of science experiences for young children throughout the world.
• Facilitate professional development opportunities for teachers by including sessions on primary science and technology in regional and international conferences.

ACTIVITIES

The Stepping into Science Team is actively involved in a number of projects and activities including:

• Publishing STEPS, the Stepping into Science Project Newsletter. This newsletter contains ideas for class activities at various levels in primary/elementary schools, activities for children to do at home, comments by network members on issues, examples of children’s work, lists of helpful resources and contacts. ICASE acknowledges the contribution of Philip Harris in sponsoring STEPS.
• Contributing articles and ideas for the Primary Science Section in Science Education International, the ICASE quarterly journal.
• Compiling ideas and activities for inclusion in a series of sourcebooks on the teaching of primary/elementary science and technology.
• Coordinating a scheme to encourage children to participate in science and technology activities. Certificates of Participation have been produced, and are available for schools to use in rewarding students as they complete a number of activities. Certificates are colour coded in seven different colours, so that they can be used to acknowledge progress in science from early to advanced levels within primary/elementary schools. ICASE is grateful to BP (Oman) for sponsoring this scheme.
• Organising Stepping into Science workshops and displays of children’s work at national, regional and international conferences.

FOR MORE INFORMATION

Contact the Project Officer:
Sue Dale Tunnicliffe
ICASE Project Officer
Stepping into Science Project
18 Octavia, Bracknell
Berkshire RG12 7YZ
United Kingdom
Closing the Educational Gaps Between Science, Technology and Society

by Paul DeHart Hurd

This excerpt is from an article by the same title published in Theory into Practice, Volume XXX, Number 4, Autumn 1991. Paul DeHart Hurd is Professor Emeritus of Education at Stanford University, USA.

Throughout history and currently, school science courses have been organised and taught as mirror images of research disciplines found in universities, such as biology, chemistry, geology, and physics. Typically, learning goals include knowing the structure and basic principles of each discipline.

Students are expected to acquire the vocabulary and language scientists use to communicate with other researchers. Learning activities are designed to encourage students 'to think like a scientist' and to acquire the mathematical and observational skills essential for doing so. The primary goal of science teaching in the upper grades has traditionally been to prepare students for college and a career in science.

This mode of science teaching has been challenged throughout the history of public education in the United States. The alternative view is to consider achievements in science in terms of benefiting the common good and fostering the welfare of individuals.

Instructional goals are seen as developing an understanding of the natural world and the acquisition of intellectual skills for living and participating in a culture that is increasingly characterised by achievements in science and technology.

The central goal for an education in the sciences in the 1990s is perceived as enculturation or scientific literacy. Over the past 200 years, the debate on the social nature of science has ripened into an educational vision that brings science, technology, and society (STS) into a common discipline. The current reform movement in science teaching calls for instructional goals and a supporting curriculum taught in a social and personal context.

<table>
<thead>
<tr>
<th>ICASE</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTERNATIONAL COUNCIL OF ASSOCIATIONS FOR SCIENCE EDUCATION</td>
</tr>
</tbody>
</table>

World Activity Day

14 October 92

Celebrating International Space Year in schools around the world

Teachers and students in schools around the world are invited to participate in the special activities on the following pages focusing on the theme of space. Member associations of ICASE are requested to encourage schools in their countries to share in this worldwide program on 14 October. The activities, which can be adapted to suit students at all primary and secondary levels, include:

1. Designing, constructing and testing rockets which operate on compressed air and water
2. Calculating the Earth's diameter by measuring the length of the shadow cast by a stick
3. Writing a short essay on (a) space travel in the year 2092 or (b) life as a student in 2092 as a result of space technology

See the following pages for an outline of these activities. Member associations are encouraged to reprint these pages in their own journals and newsletters to encourage schools to participate.
UP, UP AND AWAY
WITH BOTTLES!

An Activity for Students in Primary and Secondary Schools across the World

The age of rockets is very modern, but the science which explains how a rocket works was understood hundreds of years ago. Rockets burn fuels in a chamber shaped like a bottle with a neck pointing down. The burning fuel produces large amounts of gases expanded by heat. The gases are forced down through the neck at high speed, forcing the rocket up in the opposite direction. Isaac Newton first explained it in this way – if there is a force pushing in one direction, there is an equal force pushing in the opposite direction!

Drill a hole in the rubber stopper and insert the metal nozzle. Attach the nozzle to the pump. Quarter fill the PET bottle with water. Fit the rubber stopper and nozzle firmly into the neck of the bottle. Place the bottle upside down on a launch pad such as a cardboard carton with a hole to support the neck. Pump air into the bottle until the air pressure inside pushes the stopper out the bottom. The force of the water pushing down causes a force pushing the PET bottle up. As water is ejected, the bottle becomes lighter, and it accelerates!

This Water Rocket activity uses plastic bottles to give you hours of fun exploring this important scientific principle.

You will need:
- plastic P.E.T. bottle
- rubber stopper to firmly fit the neck of the bottle
- bicycle pump
- metal nozzle (as used in inflating basketballs, etc)

Acknowledgement

This activity is adapted from Up, Up and Away With Bottles developed by Questacon – The National Science and Technology Centre, Canberra, Australia and published in SPACELINKS, Australian Science Teachers Association 1992.
Measuring Altitude

Measure the height of the rocket by making a cardboard quadrant marked with angles from 0 to 90 degrees.

Kneel down 25 metres from the launch position. Sight along the bottom of the quadrant to the rocket.

As the rocket goes up, follow it with your forefinger along the curve of the quadrant. When it reaches its highest altitude, read the angle where your finger has stopped.

Use the table below to find out the altitude of the rocket.

<table>
<thead>
<tr>
<th>Angle (Degrees)</th>
<th>0</th>
<th>10</th>
<th>20</th>
<th>30</th>
<th>40</th>
<th>50</th>
<th>60</th>
<th>70</th>
<th>80</th>
</tr>
</thead>
<tbody>
<tr>
<td>Altitude (Metres)</td>
<td>0</td>
<td>4</td>
<td>9</td>
<td>14</td>
<td>21</td>
<td>30</td>
<td>43</td>
<td>69</td>
<td>142</td>
</tr>
</tbody>
</table>

Extra things to try

- Does the amount of water in the bottle affect the altitude of the water rocket? Design an experiment to find out. A quadrant may help you to measure altitude during your experiment. The above instructions will help you to make and use a quadrant.
- Design some fins for the PET bottle rocket. Do fins improve the flight of the rocket? If so, how?
- Try designing and making other water rockets.
MEASURING THE EARTH'S CIRCUMFERENCE

An Activity for Students in Secondary Schools across the World

Some history
Contrary to popular opinion, not everybody before Columbus believed that the Earth was flat. In fact, a remarkably accurate measurement of the Earth's circumference was made in the 3rd Century BC by Eratosthenes — an astronomer, historian, poet and director of the great library of Alexandria. He read in a papyrus manuscript that at midday on a certain day of the year at Syene (now Aswan) vertical sticks cast no shadow, and the reflection of the Sun could be seen in a deep well. He tried the experiment at Alexandria (at the mouth of the Nile) on the same day of the year and found that shadows were cast by vertical sticks.

He reasoned that the Earth was spherical and calculated its circumference as follows. The angle of the shortest shadow cast at Alexandria on that day was 7 degrees, which is about one fiftieth of a circle. He then measured the distance between Alexandria and Syene. Some say that he hired a man to pace out the distance. Others say that he used the time taken for a camel to undertake the journey. The distance was found to be 5000 stadia — kilometres were not yet in vogue — hence the circumference was calculated to be 50 x 5000 = 250,000 stadia or 46,300 km. This figure was only about 15% larger than the currently accepted value.

The measurement activity
Try this activity on World Activity Day, 14 October 92. Hopefully it will be a sunny day. You will need:

- straight rod (1 to 2 m) on a stand
- ruler
- plumb-line
- flat level surface open to sunshine during the day
- chalk or similar to mark the surface
- 3 m length of string

Early in the day (about 9 am) set up the rod on a flat level surface. Use a plumb-line to ensure that the rod is precisely vertical. Mark the position of the shadow end. Repeat marking points at half-hourly or hourly intervals as convenient. You may wish to mark points more frequently near solar noon. It does not matter if a few points are missed.

Acknowledgement
This activity is reproduced from Honeyman B & Burfitt H (eds) 1985 Australian Science in Schools Week Resource Book Australian Science Teachers Association

At the end of the day, draw a curved line through the points to trace the path of the shadow. Using a string of fixed length extended from the base of the rod, scribe two arcs that intersect the shadow path (see diagram). Use the string again to scribe the intersecting arcs from the two intersections on the shadow path. From this determine the length of the shortest shadow.

Measure the height of the rod above the surface and, using values of tangents, determine the angle of the sun at solar noon. What fraction of 360 degrees is this angle?

Determine the the distance between the point of your observation and that point on the Earth's surface where the sun is directly overhead at solar midday. This can be calculated as follows. The declination (d) of the sun on any day during the year can be found from:

\[ d = 23.45 \sin \left(360 \frac{284 + n}{365}\right) \]

where \( n \) is the day number of the year. Substitute the value of \( n \) for the date you carry out this activity. A negative value will indicate the line of latitude south of the equator where the Sun is directly overhead.

From a map, locate this latitude and determine the distance along the meridian between your position and that latitude. Use the same reasoning as Eratosthenes to calculate the circumference of the Earth.
WRITING A SHORT ESSAY
LIFESTYLE IN 2092

An Activity for Students in Primary and Secondary Schools across the World

Primary Category
Ages 5 to 8
Maximum 250 words
Write a short essay on space travel in the year 2092

Secondary Category
Ages 13 to 16
Maximum 750 words
Write a short essay on life as a student in 2092 as a result of space technology

Primary Category
Ages 9 to 12
Maximum 500 words
Write a short essay on space travel in the year 2092

Secondary Category
Ages 17 to 20
Maximum 1000 words
Write a short essay on life as a student in 2092 as a result of space technology

Forward essays, preferably typed on A4 pages, to the nearest ICASE Regional Representative below. Certificate prizes will be awarded to the 20 best entries in each region.

Mr Isaiah O Ikeobi
African Representative
Federal Ministry of Education
Science Education Division
PMB 12573, Victoria Island
Lagos, Nigeria

Dr A M Sharafuddin
Asian Representative
Secondary Science Education Project
Shikshka Bhaban, Abdul Ghani Road
Dhaka 1000
Bangladesh

Mr Maris Sillis
Australasian-Pacific Representative
University of South Australia
Smith Road
Salisbury East SA 5109
Australia

Ms Althea Maund
Caribbean-Sth American Representative
Ministry of Education
Hayes Street, St Clair
Trinidad

Drs Jan Hendriks
European Representative
Konijnenpad 3
7921 BM Zuidwolde (DR)
Netherlands

Dr Kenneth R Roy
North American Representative
Glastonbury Public Schools
330 Hubbard Street
Glastonbury, CT 06033
USA
Resources for Teaching Chemistry

Compiled by Peter E Childs and Marie Walsh

The Schools Information Centre on the Irish Chemical Industry has produced this publication as a service to practising teachers of chemistry. The guide to resources, published in November 1990, includes information on materials available from industry as well as on resources available from commercial sources. Booklets, posters, videos, slides, and software are listed in this directory.

Resources available from Irish companies are supplemented by resources from the UK, USA and other overseas companies. A number of museums and interactive centres are also listed in this 104 page directory. The directory can be purchased from:

Schools Information Centre on the Irish Chemical Industry
University of Limerick
Plassey, Limerick
Ireland

at the following cost:
- Cost within Ireland/UK: £3.00 per copy including postage & packaging
- Cost in other countries: £4.00 per copy including postage & packaging

Report on Third Nordic Conference on Science and Technology Education

The report on this Conference, organised by the Centre for Science Education of the University of Oslo and held in Norway in August 1991, is now available. The theme of the Conference was Science Education and the Environment. The 200 page report contains papers on various aspects of environmental science education, including details of the Baltic Sea Project and plans for a North Sea Project. Available for £5 plus 30% postage from the ICASE Hon Treasurer, Knapp Hill, South Harting, Petersfield GU31 5LR, UK.

NEW ICASE PUBLICATION

Who's Who in Science Education Around the World
1991 Edition

Who's Who in Science Education Around the World

Published by ICASE
With assistance from UNESCO

1991 Edition

This new ICASE publication, published with the assistance of UNESCO, contains brief profiles on prominent science educators, their work, their projects and their interests. The valuable reference book includes key women and men in many countries throughout the world who are contributing to science education at primary, secondary or tertiary levels.

The information will help readers to contact colleagues in both developing and developed countries who may be working on projects of interest to them, who may be potential speakers at upcoming meetings or conventions, and who may be invited to work on collaborative projects.

Copies at a cost of US$15.00 or £9.00 or A$20.00 including postage can be ordered from the Editor:

Brenton Honeyman, Editor
10 Hawken Street, Monash, ACT 2904, Australia

or

Dr Jack Holbrook, Executive Secretary, ICASE
Dept of Curriculum Studies, University of Hong Kong
Hong Kong

Dennis Chisman, Honorary Treasurer, ICASE
Knapp Hill, South Harting, Petersfield GU31 5LR, UK

Cheques payable to "ICASE"

31
What role do museums play in promoting the public understanding of science? This book of discussion papers looks at the museum as an educational resource, as a medium of communication, and as a message. Contributors are drawn from museums, visitor centres, and universities in the UK, France, and North America.

Museums and the Public Understanding of Science, John Durant (ed), Science Museum in association with the Committee on the Public Understanding of Science, 1992, ISBN 0 901805 49 1, £9.95 (plus £1.28 p&p for mail orders within the UK). To be published March 1992. Copies of Science Museum books are available by mail order from Dillons at the Science Museum, Exhibition Road, London SW7 2DD (payment with order). If you want to know more about our list, please write to Victoria Smith at the Science Museum.

Science, Mathematics & Technology for All: Towards a Better Society

Proceedings of the Sixth ICASE Asian Symposium published by Brunei Association for Science Education

The Symposium, organised by the Brunei Association for Science Education and ICASE in association with the Ministry of Education, Brunei Darussalam, was held at the Universiti Brunei Darussalam, 4-10 December 1989.

The recently published proceedings (234 pages) contain full papers for the 3 plenary sessions, and 20 other sessions. Abstracts of all other presentations are also given (full papers can be obtained from BASE or the ICASE Secretariat).

The keynote presentation by Prof John K Gilbert (University of Reading, UK) addressed the topic Educating the Science and Mathematics Teachers for All, and focused on the change in the nature and provision of school-level science and mathematics education underway in many countries, and the implications for teacher education.

Other papers which are included in this proceedings are 'Science and Technology: Some Perspectives' by D J Daniels of Brunei; 'Science Centres as Non-formal Agents for Science, Technology and Mathematics Education for All' by Leo W H Tan of Singapore; 'Science for All' by Jack Holbrook of Hong Kong; 'Science Technology and Society: Implications for Better Decision Making' by Lucille C Gregorio of Thailand; 'Images of Science and Technology' by Doug Hill of Australia; 'Projects in Science Technology Education: The Setting up of a Computerised Information Exchange' by K Riquarts & H Waldow of Germany; 'Difference in Concepts between Urban and Rural Children of Bangladesh' by I A Muttaqui and A J Ara of Bangladesh; and 'Role Play in Science Education' by Asoka Weerasinghe of Sri Lanka.
ICASE is keen to arrange regional or world events for the benefit of member associations. If your association or organisation is interested in hosting an international seminar, workshop or conference, contact the Executive Secretary or your Regional Representative. To gain ICASE endorsement, the meeting must be international in nature, open to member associations, and, while all sectors of the science education community should be encouraged to participate, must be relevant to classroom teachers.

1992

March 26-29
NSTA National Convention
Location: Boston, MA, USA
International delegates are invited to participate in the International Round Table - one of the many features of this large convention. Each country is provided one or more tables in a large room where delegates can display and present information on science education in their country. Visitors move from table to table, talking with the various representatives. Contact: John E Penick, Professor and Coordinator, Science Education Center, The University of Iowa, Iowa City, Iowa 52242, USA.

March 26-28
Les Journees Informatique et Pedagogie des Science Physiques
Location: France
Contact: F M Blondel, Informatique et Enseignement, Institut National de Recherche Pedagogique, 91 rue Gabriel Peri, 92120 Montrouge, France
This meeting on Informatics and Pedagogics in Science is being organised by l'Union des Physiciens (UdP), the Association of Physics and Chemistry Teachers.

March 29 - April 10
Seminar on Science Teacher Education
Location: King's College London, UK
Contact: Courses Department, The British Council, 10 Spring Gardens, London SW1A 2BN, UK
This British Council International Seminar will focus on secondary level teacher education, although some aspects will be of interest to those involved in primary science teaching. Six areas will be addressed: What is the nature of science education for schools?; To what extent should teacher education reflect and shape societies' values and cultural traditions?; How can we aid their professional development so that science teachers have the skills they need in the classroom and laboratory?; What can the results of research tell us about new ways to approach children's learning and classroom practice?; How is the work of pupils, teachers and trainees to be evaluated?; How does the structure of national and regional administration affect the management of teacher education? There are vacancies for 30 international participants - practising teacher trainers, advisers, inspectors, organisers of professional development programs and policy maker.

April 26-May 1
International Conference on Technology Education - INCOTE 92
Location: Weimar, Germany
Contact: Dr D Blandow, INCOTE 92, Pädagogische Hochschule, Nordhäuserstraße 63, 0-5063 Erfurt, Germany
This conference, organised in collaboration with a number of organisations including ICASE and INISTE, aims to bring education and industry together to consider the goals, methods and organisation of technology education; share practice aimed at developing technological literacy enabling all people to contribute to a modern society; discuss the value of technological approaches for delivering other learning and enhancing human capabilities, and to establish an umbrella organisation for networking information and contacts. The majority of participants will be from European countries, with a few key people from other regions of the world. The principal language of the symposium will be English.

May 11-15
Second International History Philosophy and Science Teaching Conference
Location: Queen's University, Kingston, Ontario, Canada
Contact: Prof Skip Hills, Faculty of Education, Queen's University, Kingston, Ontario, Canada K7L 3N6
This conference follows the very successful First International Conference on History, Philosophy and Science Teaching held at Florida State University in November 1989. All conference papers will be published in advance of the conference.

May 11-22
Seminar on Developments in Primary Science Education
Location: Liverpool, UK
Contact: Courses Department, The British Council, 10 Spring Gardens, London SW1A 2BN, UK
This British Council Seminar will examine major concerns and activities in primary science in the UK as well as their international context and implications. Major research and development projects in the area of science and technology relevant to the primary phase will be represented, including Learning in science, Research into children's ideas, Contexts of learning, Out of school learning, Curriculum development and evaluation, Pupil assessment, and Teacher education. There are vacancies for 35 participants, including science educators and curriculum developers concerned with the primary phase.
June 10-12
ICASE Research Seminar on Chemistry and Physics Education
Location: University of Dortmund, Germany
Contact: Prof Dr Hans-Jürgen Schmidt, University of Dortmund, Department of Chemistry, Otto-Hahn-Straße, 4600 Dortmund 50, Germany
This symposium on empirical research in chemistry and physics education will focus on the methodology of empirical research in this field. There will be approximately 12 presentations each followed by a discussion period. The language of the symposium will be English. Presenters will be asked to send their paper beforehand, ready for printing as Proceedings through ICASE. Although there will be no seminar fee, participants will need to cover their own expenses.

July 6-10
CONASTA 41
Location: University of Western Australia, Perth, Western Australia
Contact: Nic Soufolis, Convener CONASTA 41, Science Teachers Association of WA, PO Box 222, Claremont, WA 6010 Australia (Fax +61-9-385-1509)
The Australian Science Teachers Association invites you to participate in the forty first annual conference of the Association. The theme of Science and our Economic Future will be addressed from the viewpoints of government, scientific research, applied science and technology, the environment, industry and commerce, and education. Outstanding national and international educators, scientists and classroom practitioners will present keynote addresses and workshops, and a variety of excursions will be offered. A comprehensive display of resources useful to science teachers will be presented by publishers, booksellers, equipment and computing companies.

July 22 - August 5
34th London International Youth Science Forum
Location: London, UK
Contact: LIYSF, PO Box 159, London SW10 9QX, UK, Fax 071-835-1070
The Science Forum is the principal annual meeting in Britain of young scientists. Over three hundred students attend from some fifty nations to make this an international event of major significance. The program features lectures, seminars and demonstrations from leading scientific names, and an extensive range of visits to university and industrial research establishments in London, Oxford, Cambridge and other centres in southern England. Accommodation in London University Halls of Residence together with all meals and a supporting social program are included in the participation fee of £650.

August 2-10
Eighth ICASE Asian Symposium
Location: Colombo, Sri Lanka
Contact: Mr Asoka Weerasinghe
Hon. Joint Secretary, SLASME, Institute of Computer Technology, PO Box 1490, Colombo, Sri Lanka
Science educators are invited to attend the eighth ICASE Asian Symposium and enjoy the natural beauty of the country and the hospitality of the Sri Lankans. The Symposium, organised jointly by ICASE and the Sri Lanka Association for Science and Mathematics Education (SLASME), will feature outstanding speakers from many countries who will address the theme "Science Education for a Changing World". The Symposium aims to identify some of the changes affecting our daily lives and to discuss ways by which science education can respond to these changes. Subthemes include (1) technology, (2) appropriate technology, (3) environment, and (4) scientific literacy. Participants will be able to experience the world famous pageant "The Kandy Perahera" in Sri Lanka. 100-150 science and mathematics educators from all parts of the world, and 200-250 local delegates are expected to participate in this event.

August 31 - September 3
SCICON Biennial Conference of NZSTA
Location: University of Waikato, Hamilton, New Zealand
Contact: Neal Utting, Education Advisory Service, 4 Hill Street, Hamilton, New Zealand
The theme of SCICON for 1992 will be Science - Technology . . . A Partnership . Information and registration forms about the biennial national conference of the New Zealand Science Teachers Association can be obtained from the contact above.

September 19-21
Second General Conference of Teachers
Location: Poland
Contact: SNPPiT, Skrypta Pocztowa 62, 85-791 Bydgoszcz 32, Poland
This second General Conference on the theme 'Education, Environmental Protection and Industry' is being organised by the Association of Science and Technology Teachers (SNPPiT), Poland. Languages used will be Polish and English.

December 17-21
Twelfth International Conference on Chemical Education
Location: Bangkok, Thailand
Contact: Dr Somjai Wichaidit, The Secretariat - 12th ICCE, c/o Research Centre, Faculty of Medicine, Ramathibodi Hospital, Rama 6 Road, Bangkok 10400, Thailand
The theme of the Twelfth International Conference on Chemical Education will be Chemistry in Transition and it is hoped that the participants will interpret this in many different ways. This biennial Conference, to be held for the first time in South East Asia, is organised by the Committee on Teaching of Chemistry of the International Union of Pure & Applied Chemistry, and The Chemical Society of Thailand in cooperation with UNESCO. It is attended by chemistry teachers at both high school and university levels who wish to improve their teaching and to learn from one another techniques and experiences. A second circular including instructions for submitting abstracts is available in March 1992 to those responding to the address above.
January
ASE Annual Meeting
Location: UK
Contact: Annual Meeting Secretary, ASE Headquaters, College Lane, Hatfield AL10 9AA, UK
Full details of this large international event will be circulated in Education in Science, a journal of the Association for Science Education.

January 3-8
International Conference on Science Education in Developing Countries
Location: The Amos De-Shalit Israeli Science Teaching Center, Israel
Contact: Conference Secretariat, ORTRA Ltd, 2 Kaufman St, PO Box 50432, 61500 Tel-Aviv, Israel (conference arrangements) or Dr Avi Hofstein, Department of Science Teaching, The Weizmann Institute of Science, Rehovot 76100, Israel (academic correspondence)
This international conference on the theme "Science Education in Developing Countries: From Theory to Practice" will review past experiences and achievements in science education and plan for the 21st century with a special focus on developing countries. The conference will feature plenary lectures, symposia, poster sessions, workshops, exhibitions, informal discussions, social events and local visits. Topics for symposia and plenary lectures will focus on current research on learning and teaching and its implications for (1) the learner, (2) the teacher, (3) the classroom, and (4) the curriculum.

April 21-25
International Conference on Geoscience Education and Training
Location: University of Southampton, UK
Contact: Mrs Esther Johnson, GEOED Conference Secretariat, Department of Geology, University of Southampton, Southampton S09 5NH, UK
The Association of Geoscientists for International Development (AGID) and the Commission on Geoscience Education and Training (COGEOED) of the International Union of Geological Sciences are convening this international conference with the support of ICASE. Themes include: geoscience education in schools; higher education; geoscience training for business, industry and public service; and public understanding of geoscience. The conference is open to all those with an interest in geoscience education and training - including practitioners and those involved in administration, course development, and the supply of resource materials.

June 27 - July 3
VII Pacific Science Inter-Congress
Location: Okinawa Convention Center, Okinawa, Japan
Contact: VII Pacific Science Inter-Congress, c/o Section of International Affairs, University of the Ryukyus, 1-Senbaru, Nishihara, Okinawa, 903-01, Japan

ICASE ENDOWMENT FUND

Associations and individuals are invited to contribute to this fund to support the activities of ICASE

For further details, contact

Dennis Chisman
ICASE Honorary Treasurer
Knapp Hill
South Harting
Petersfield GU31 5LR
UK

The Symposium will be organised around the theme The Pacific: Crossroads for Culture and Nature and subthemes (1) Cultural Interchange among Pacific Peoples; (2) Speciation, Dispersal and Conservation of Species in the Pacific; (3) Towards Appropriate Technologies and Policies for Development and for the Conservation of Natural Environments in the Pacific. Scientific sessions organised by the Scientific Committees of the Pacific Science Association focus on a range of science disciplines and issues, including Science Communication and Education.

July
Conference 93
Location: Paris, France
Contact: Dr Jack Holbrook, ICASE Executive Secretary, Department of Curriculum Studies, University of Hong Kong, Hong Kong.
This worldwide conference, organised by ICASE in conjunction with Unesco and other international bodies including ICSU Committee on Teaching of Science, is the second phase of the three phase Project 2000+ (refer to September 1991 issue for more details of this project). A number of international and regional conferences will generate input into Conference 93. The theme of the conference addresses the issue of Scientific and Technological Literacy for All. Sessions will establish agendas for future action. The majority of delegate places will be filled by invitation.

July 28 - August 11
London International Youth Science Forum
Location: London, UK
Contact: LIFYF, PO Box 159, London SW10 9QX
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Extending and improving education in science
for all children and youth by assisting
member associations throughout the world

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Science Education International is the Quarterly Journal of the International Council of Associations for Science Education. ICASE was established in 1973 to extend and improve education in science for all children and youth by assisting member associations throughout the world.

This journal provides a means for associations, institutions, centres, foundations, companies and individuals concerned with science education, to share perspectives, concerns, ideas and information which will foster cooperative efforts to improve science education, and which will serve as a chronicle of the advancement of science education throughout the world.

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Dates for Receipt of Contributions

<table>
<thead>
<tr>
<th>Issue</th>
<th>Closing Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>March</td>
<td>1 February</td>
</tr>
<tr>
<td>June</td>
<td>1 May</td>
</tr>
<tr>
<td>September</td>
<td>1 August</td>
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<tr>
<td>December</td>
<td>1 November</td>
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Project 2000+
Request for articles and reports on scientific and technological literacy

By John E Penick
ICASE Special Projects Officer

As part of the ICASE/UNESCO Project 2000+, focusing on developing scientific and technological literacy, we are collecting articles and reports related to scientific and technological literacy. These papers will be compiled into an annotated bibliography as well as a summary and analysis and distributed to science educators throughout the world.

To do this compilation, I am requesting your help in obtaining copies of articles or other works, published and unpublished, relating to six aspects of scientific and technological literacy:

1. The need for scientific and technological literacy: a rationale for scientific and technological literacy; demystifying science and technology; life long science and technology literacy; research into scientific and technological literacy; case studies and exemplars
2. Scientific and technological literacy for development
3. The teaching and learning environment for scientific and technological literacy
4. Formal and informal development of scientific and technological literacy
5. Teacher education for scientific and technological literacy
6. Assessment and evaluation for scientific and technological literacy

Please forward editorials, research papers, desired goals and action, and descriptions of programs. These do not need to be in English but, if they are not, it would be useful to provide an English abstract.

Please search whatever local and regional literature you have available.

This section provides news for the information of member associations, institutions, centres, foundations and companies. The Executive Committee encourages members to reproduce this section in journals and newsletters to communicate this information to as many as possible.

Russian Association of Biology Teachers joins ICASE

ICASE welcomes the Russian Association of Biology Teachers (RABT) as a Full Member. Alexander I Nikishov, President of the Russian Association of Biology Teachers has provided the following information about this new association:

The Russian Association of Biology Teachers is a non-government organisation. It was founded in 1991 to unite biology teachers, as well as others who contribute to the development of secondary school biology education. Any citizen of Russia, or citizens of other countries who participate in the activities of the Association, can become a member.

The objectives of RABT are to:

- provide support and assistance to teachers of biology in their work
- improve and develop school biology education
- upgrade the skills of biology teachers
- research, support and disseminate advanced pedagogical methods
- assist in the organisation of school competitions in biology; identify gifted children and extend their interests in biology
- provide gratuitous aid to boarding schools for children disabled at birth, and to orphans, by supplying didactic and popular scientific materials

RABT takes an active part in the development of school biology education by preparing educational and methodological materials on biology. More than 1000 educators from Russia, Belorus, Ukraine, Azerbaijan, Georgia, Lithuania and other countries are members, and the Association is linking itself with foreign and international education organisations.

For further information write to:
Dr Vjacheslav M Dushenkov, Moscow Pedagogical State University, Department of Zoology and Ecology, Kibalchicha 6, Building 5, 129278 Moscow, Russia.

Photo: John E Penick, ICASE Special Projects Officer. Dr Penick is Professor and Head of the Science Education Center at The University of Iowa, Iowa City, USA. Prior to 1989, he was the North American Regional Representative for ICASE. Dr Penick is a member of the planning committee for the ICASE/UNESCO Project 2000+.
ICASE Membership Continues to Grow

Association de Professeurs des Science Quebec
ICASE welcomes Association de Professeurs des Science Quebec (APSQ), the long-established science teachers association in French speaking Quebec, Canada.

Longman International Education

Cambridge University Press
Cambridge University Press, The Edinburgh Building, Shaftesbury Road, Cambridge, CB2 2RU, UK joins ICASE as a Company Member.

Both these publishers are very involved in science education throughout the world, and ICASE is pleased to welcome them into membership.

AKZO N.V.
AKZO, an international chemical company based in the Netherlands, with products ranging from salt, fibres, coatings, health care products and general chemicals, has recently become a Company Member of ICASE. ICASE welcomes AKZO into membership. The correspondent is:

Mrs (Drs) S C M de Maat
AKZO N.V.
PO Box 9300
6800 SB Arnhem
The Netherlands

Come and Share
A great success at ASE Annual Meeting
Sheffield University, UK
January 1992

The ICASE Stepping into Science Project, led by Sue Dale Tunnicliffe, made quite an impact at the Come and Share Workshop held at the ASE Annual Meeting in January earlier this year. The photo below shows some of the participants engaged in the exciting activities shared at this popular session. Another Come and Share Workshop is being planned for the 1993 meeting - plan now to take part!
Project 2000+
Scientific and Technological Literacy for All

by Dr Jack B Holbrook
Executive Secretary, ICASE

What should we teach in science (and technology) classes?

If we consider the science to be taught at the primary and junior secondary levels (basically the compulsory years of schooling), what is its purpose? What is the role of science education taught in schools today? Why do we teach science?

We can dismiss the arguments because the topic is in the curriculum or to pass the examination as that really begs the question and is no educational answer. Change the curriculum or examination and we change the outlook.

Project 2000+ is being initiated to raise a concern worldwide and to draw attention to the goals of science education, through science and technology education, for a literate society in the 21st century.

A past goal that has strongly influenced science teaching, especially in the selection of curricula materials at the compulsory years of schooling, is the wish to turn students into little scientists. The plan has been to train students to do as scientists do, to think as scientists think, and to have attitudes pertaining to scientists. But this often has little to do with everyday life, even if we add examples of the scientific principles to the end of teaching topics.

You may care to reflect on whether we teach mathematics to turn students into mathematicians, or history to turn students into historians, or technology to turn students into technologists. I suspect your answer would be, not really. In fact very few students go on to be scientists and few nations want so many scientists that they wish to teach the subjects to thousands of students every year solely for this purpose. So why should behaving as little scientists be a major goal for science education?

Project 2000+ as part of general education is being initiated to examine the role science and technology education is expected to play in providing basic education in the 21st century at a time when technological change is occurring at a faster and faster pace, and when science data is accumulating faster than traditional libraries can cope.

An important viewpoint that forms a basic premise for Project 2000+ is that science education as a school discipline must have educational aims that relate to the society and to the individual. These aims should bring science education and technology education closer and closer together, so much so that it is more appropriate to express these aims for both science and technology education together. The following defines a scientifically/technologically literate person (NSTA, 1990-91) and forms an appropriate starting point for discussion and expansion:

- uses concepts of science and of technology as well as an informed reflection of ethical values in solving everyday problems and making responsible decisions in everyday life, including work and leisure
- engages in responsible personal and civic actions after weighing the possible consequences of alternative options
- defends decisions and actions using rational argument based on evidence
- engages in science and technology for the excitement and the explanations they provide
- displays curiosity about and appreciation of the natural and human-made world
- applies skepticism, careful methods, logical reasoning, and creativity in investigating the observable universe
- values scientific research and technological problem solving
- locates, collects, analyses, and evaluates sources of scientific and technological information and uses these sources in solving problems, making decisions, and taking actions
- distinguishes between scientific and technological evidence and personal opinion and between reliable and unreliable information
- remains open to new evidence and the tentativeness of scientific/technological knowledge
- recognises the strengths and limitations of science and technology for advancing human welfare
- analyses interactions among science, technology and society
- connects science and technology to other human endeavours (eg history, mathematics, the arts, and the humanities)
- considers the political, economic, moral and ethical aspects of science and technology as they relate to personal and global issues
- offers explanations of natural phenomena which may be tested for their validity

Are these the most appropriate goals for science and technology education in the future during the compulsory years of schooling? They appear to fit with the expressed goal of education suggested at the World Conference on Education for All (WCAFE, 1990), addressing the issue of basic education, which pointed out that education is more than an end in itself. It is the foundation for lifelong
learning and human development on which countries may build systematically further levels and types of education and training.'

PROJECT 2000+, which has been initiated by UNESCO and the International Council of Associations for Science Education (ICASE) to draw attention to the poor state of science and technology education at the compulsory level of schooling in many countries, both in the developed and the developing world, focuses on the scientific and technological dimensions of this basic education in the context of education for all and initiates debate on the appropriate goals for science and technology education for all for the 21st century.

The project recognises that the above objectives are of little practical use in putting forward curricula, in training educators or in expressing learning practice either in the classroom or in non-formal settings. But such factors form areas of focus for the project.

In PROJECT 2000+ attention is initially drawn to:

(a) The Meaning of Scientific Literacy, Technological Literacy, and their Interrelationship

This focuses on the need to examine the nature of science and its relationship to literacy, the nature of technology education, the interdependence of science education and technology education, the interdependence of science education and technology education and vice versa, and the misconceptions held about the meaning and provision of technology education.

(b) A Rationale for Scientific and Technological Literacy

Scientific and technological literacy are essential for all, because of the increasing impact of science and technology on people's lives, individually and in relation to societal, citizenship, career and quality of life issues in the community, the state, and on a global basis.

(c) Demystifying Science and Technology

To demystify science and technology, they must become accessible to all. Fears that these subjects are hard and remote must be overcome, preferably by initiating children into using and thinking about science and technology concepts and processes at an early age.

In summary, PROJECT 2000+

• recognizes the growing need for a more scientifically and technologically literate society;
• clearly identifies ways of promoting the development of scientific and technological literacy for all;
• puts forward educational programs (formal and non-formal) in such a way as to empower all to satisfy their basic needs and be productive in an increasingly technological society;
• provides guidelines for the continuous professional development of science and technology educators;
• supports the development of a wide range of projects that aim to improve quality of life and productivity in society and that lead to promoting solidarity and cooperation in achieving scientific and technological literacy for all.

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Wanted!

Science Activities Around the World

Examples of simple, hands-on science activities especially those with a local, or regional flavour

ICASE is compiling a book of Science Activities Around the World
Make sure your activity
and your name as the person submitting it is included

Send materials to John E Penick
789 VAN ALLEN HALL, THE UNIVERSITY OF IOWA
IOWA CITY, IA 52242-1478, USA
ICASE has been greatly encouraged by the comments from individuals and Science Teacher Associations on the suitability of Project 2000+. ICASE is now forging ahead in partnership with UNESCO to make the project a reality and to lay concrete plans for an international forum to be held in Paris, July 1993. ICASE hopes many educators linked with Science Teacher Associations will be able to attend the forum, even though, in total, only 500 participants are possible. Already steps have been taken to seek funding to assist those STAs where money is a problem, although nothing is finalised at this stage.

Your interest in this project is now being sought, especially of persons who would like to be involved in participating in the international forum and in helping science teacher associations to be involved in national developments at Phase 3. Please write to the ICASE secretary, Dr Jack Holbrook. ICASE is keen to invite persons with international involvement and those involved with national (regional) Science Teacher Associations.

Initiating Project 2000+

Project 2000+, an initiative of ICASE in partnership with UNESCO, has two main operational parts:

1. A five day working forum to be held at UNESCO headquarters, Paris in July 1993 seeking definition, resolution, and action, and

2. A coordinated sequence of meetings, national working groups, task forces and political action aimed at enhancing basic science and technology education for all, throughout the world so as to improve scientific and technological literacy.

For Project 2000+ to be successful, UNESCO, ICASE and other organisations worldwide plan to mobilise support to give proper visibility to the project. This visibility is to be enhanced by:

- contacting interested partners who could contribute financially, technically and intellectually;
- jointly planning and describing roles of each partner and the activities which need to be carried out in various phases of Project 2000+;

Project 2000+ will also initiate actions such as:

- drafting statements of a political and professional nature for discussion in the international forum;
- initiating pilot projects designing and implementing specific programs of teacher enhancement, research, and curriculum development;
- designing an evaluation component of Project 2000+;
- drafting guidelines for designing, implementing, and evaluating curricula and projects in the post-forum phase;
- completing databases suitable for fast, easy access of relevant research and editorial materials as well as teaching material for scientific and technological literacy.

Prior to the forum, information, experiences, and example materials related to scientific and technological literacy will be collected. Everyone involved with the forum will be expected to assist with this. Including the data collecting aspect, there are thus essentially three phases to Project 2000+.

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**ICASE AWARD SCHEME**

*for outstanding contributions to international science education*

**Nominations for these awards must be forwarded by member associations of ICASE. For full details of how to forward nominations, contact the Executive Secretary below.**

**ICASE Distinguished Service Award**

This award is made to individuals who have a career history of distinguished service to international science education through their involvement in the international activities of local, regional and global science education organisations.

**ICASE Regional Service Award**

This award honours individuals who have made a significant contribution to international science education through their involvement in international activities at the local and regional levels.

**ICASE Association Award**

This award recognises individuals who, within their science teacher association, have made a significant contribution to the international activity of their association.

Contact Dr Jack Holbrook, Executive Secretary ICASE

Department of Curriculum Studies, University of Hong Kong, Hong Kong
Phase 1 - Planning, Information Gathering, and Initiating Pilot Projects

During Phase 1, the proposals for Project 2000+ will be further developed, funding sought, and materials collected. Systematic searches of the literature will produce summary documents on various aspects of scientific and technological literacy, including definitions, appropriate classroom climate, assessment and so on.

Additional information will be collected relating to education reforms, exemplary materials and practices, and projects aimed at satisfying basic needs (environment, health, nutrition), improving productivity (agriculture), and meeting basic demands created locally by the presence of industries. Examples of materials related to good classroom practices, good teacher education methods and good assessment and evaluative techniques will also be collected. This will include non-written materials such as slides, videotapes, computer programs, tape recordings and toys and games.

Projects which are designed to contribute to scientific and technological literacy will be piloted and preparatory work will begin on designing and creating databases which will support both discussion in the forum and plans for the post-forum phase.

Project 2000+ will include provision for disseminating information related to focus areas of Project 2000+. To do so requires:

- identifying and compiling relevant articles and activities from around the world;
- obtaining and preparing outcomes from relevant meetings prior to the forum to be held in July 1993;
- initiating the preparation of databases to compile and access information relating to scientific and technological literacy as well as the institutions and networks promoting such literacy.

Phase 2 - Discussing the Issues and Putting Forward Outcomes

Phase 2 will be an International Forum, held at UNESCO headquarters, Paris, in July 1993, to discuss issues identified during Phase 1 with a view to:

- issuing statements to effect political visibility for science and technology education for all as a requirement for both individual and national development;
- providing a framework for major programs of action in science and technology education involving Governments, Inter-Governmental Organizations (IGOs) and Non-Governmental Organizations (NGOs such as Science and Technology Teacher Associations);
- developing guidelines for designing, implementing and evaluating projects in Phase 3

During the International Forum in July 1993, persons with an interest in scientific and technological literacy will discuss evidence and issues. The forum will be expected to examine ways of seeking the development of scientific and technological literacy for all, paying attention to formal and non-formal educational opportunities while considering six specific Focus Areas as outlined below:

1. The Nature of and the Need for Scientific and Technological Literacy

Scientific and technological literacy are basic to any education for the 21st century. Without such literacy, citizens will be poorly prepared for learning to cope with an increasingly technological environment and lifestyle and thus:

- the need for scientists, politicians and other key personnel to be scientifically and technologically literate as a basis for decision making to be able to participate meaningfully in science-related political issues;
- the need for people to be functional in an increasingly technological environment; 'operate' in relation to machines; develop appropriate societal behaviour for the benefit of the individual, society and the environment as a whole;

2. Scientific and Technological Literacy for Development

Areas for consideration include national social, environmental and economic development with particular respect to:

- personal development including human and ethical values;
- quality of life issues such as sustainable development strategies, the environment, energy, population, and health;
- economic development, opportunities for employment at local, regional and national levels.

This particularly applies to:

(a) Life-long Science and Technology Literacy

As science and technology develop, now and in the future, efforts have to be made to prepare and sustain science and technology literacy throughout life. Efforts to promote public understanding of science and technology, for example through the media, in the local community, must complement formal education systems.

(b) Research into Scientific and Technological Literacy

Serious research efforts must begin to investigate needed basic concepts, the knowledge base, processes, and skills related to scientific and technological literacy. Further research must consider teacher education, learning environments, and career-related issues.

(c) Case Studies and Examples of Scientific and Technological Literacy in various settings

Descriptions of existing literacy programs and activities will stimulate discussion, research, and action. Such examples are essential for developing modes for educational development.

3. The Teaching and Learning Environment for Scientific and Technological Literacy

The ultimate goal of scientific and technological literacy is an individual who feels comfortable with and capable of learning and using science and technology. In developing this literacy, teaching must focus on the individual. Such focus requires a carefully planned and created learning environment. This learning environment includes:

- the role of the learner
- the role of the teacher
• the curriculum, and
• the physical environment where the learning is to take place

The desired role of the learner must be compatible with the nature of science and scientific literacy and what is known about how people learn. To be useful, this role must be carefully described and documented quite specifically.

Once the role of the learner is specified, a careful search of the literature should reveal appropriate teacher behaviour and actions which should lead to learners performing as desired. At the same time, a number of teacher roles and behaviours not desired will be identified. Combining these with a thorough analysis should lead to appropriate teaching strategies for enhancing scientific and technological literacy.

Since learners interact with the teacher in a context and physical locale, these too, must be designed for compatibility with the ultimate goal, scientific and technological literacy.

(4) Teacher and Leadership Education for Scientific and Technological Literacy

The teacher and/or leader is a key figure in the learning environment. Hence, the teacher's and leader's own education must be carefully planned to optimise the learning environment. Teachers (and others directing an environment for developing scientific and technological literacy) must consider and control the learning environment and their own behaviours. If this is to occur, the personal education of teachers, leaders and directors must be equally well-considered and implemented. Such consideration will probably include:

• necessary background knowledge
• knowledge about teaching and learning
• appropriate attitude and commitment
• competence with appropriate teaching strategies
• ability to select, modify, and design curriculum

To achieve these, programs for educating leaders and educators must have specific components which lead to the capabilities desired.

(5) Assessment and Evaluation for Scientific and Technological Literacy

Whereas assessment is most commonly used in formal school classrooms there is a need to use evaluation as a tool for accountability in all scientific and technological literacy programs. Educators need to assess regularly and meaningfully the academic achievement of their pupils. But, equally important, teachers must devise methods for monitoring their own teaching programs and the system in which they carry out their profession.

There are many issues to focus on, but attention should be drawn to:

• the need for valid assessment and evaluation for all desired goals (attitudes, creativity, the nature of science, application of knowledge), not just knowledge of concepts, vocabulary, and processes;
• the role of assessment and evaluation;
• public acceptability of appropriate assessment and evaluation;
• how such assessments/evaluations can be identified and monitored in formal and non-formal situations;
• use of formative as well as summative evaluation strategies;
• self-evaluation for users of technology;
• mechanisms for collecting relevant data;
• the role of evaluation agencies.

Assessment and evaluation should provide usable information for improving the quality of life and measuring the needs of a flexible workforce which can be more effective if scientifically and technologically literate.

(6) Non-formal Development of Scientific and Technological Literacy

While formal schooling provides a major mechanism for enhancement of scientific and technological literacy, non-formal (museums; science centres; zoos; science clubs, fairs and camps) and informal (the media, science magazines, events, art, music) also provide significant avenues for development. In fact, for adults and out-of-school youth, these may play the major role. Knowing these, serious proposals must consider:

• identifying, supporting and publicising non-formal and informal mechanisms;
• the education of personnel for non-formal and informal efforts;
• linking schools with non-formal and informal institutions, events and mechanisms;
• evaluating the effectiveness of various non-formal and informal approaches.

There is a wide range of institutions and organisations involved in informal and non-formal education. These include national academies of science, associations for the advancement of science, and science teachers' professional associations as well as literacy adult education and distance education programs.

With these aspects considered, the role of non-formal and informal education is anticipated to improve and complement that found in the more formal school setting. Simultaneously, adult scientific and technological literacy would be enhanced. And, since both non-formal and informal mechanisms involve mixed age groups, learning will be better viewed as a family and life-long affair.

Approximately 500 participants will convene in Paris in July 6-11, 1993. These will include:

• about 100 key science and technology educators, invited on the basis of their ability to provide support material, to assist and guide discussions. They will also have a significant role in the production of phase 2 products;
• about 100 science and technology educators invited because of their institutional affiliations and interest in initiating phase 3 developments;
• government-sponsored high level officials, associated with EFA national programs, and interested in phase 3
developments;

• persons from the media who can give the project and its aims prominence around the world and thus assist the project to make an impact during phase 3;

• industrialists and technologists (both indigenous and advanced) who can guide career aspirations and provide guidance for scientific and technological literacy in areas such as risk assessment, health and safety at the workplace, creativity and attitudes and adaptability towards 'new' technologies.

All participants would be placed in one of the 6 focus areas. Each focus group will include a diverse selection of individuals, having a rational balance of world regions, women and men, EFA representatives, STAs, teacher educators, non-formal education groups and others.

Phase 3 - Action Phase

Phase 3 will follow the forum. Encouragement will be given to set up special task forces involving Governmental and Non-Governmental Organizations, linked with groups working in the field of education for all, to design and supervise the implementation of projects at the national level. The international community, also made up of IGOs and NGOs, would play a multi-faceted role, serving as catalyst and broker while providing technical and logistic support and funding.

The global aspects of Phase 3 are anticipated to be:

• an international secretariat

• task forces

• support groups

• international communication network

• international databases

Post-forum action will involve:

• convincing countries that scientific and technological literacy is important and that greater efforts are needed for more relevant teaching and non-formal education;

• recognising the need and finding ways to support a greater degree of non-Government input into supporting teachers and non-formal education.

Internationally, efforts will also be made to improve scientific and technological literacy and make the project more visible by:

• publishing a project 2000+ periodical;

• mentioning projects that have been up and running in a region (crucial here is the link between development-implementation and classroom practice);

• stimulating small, regional working conferences where the process and results of projects are discussed and reviewed (reports to be published in the newsletter);

• initiating more teacher in-service programs (international organisations can help by providing examples of guidelines, source reference materials and lists of contact addresses);

• making known internationally more information and evaluative data on projects trialled around the world by making use of task forces; providing support groups to assist, if needed, in the design of projects appropriate for a system on the scientific and technological needs in the region and/or the necessary training for local personnel;

• assisting in the trialling of materials in countries by providing expertise support if needed through support groups; assisting the evaluation of trials and more extensive studies by providing expertise if need through the support groups; using international task forces to obtain the information needed for databases in support of national developments.

The local part of Phase 3 will be the National Programs operating at the Governmental, the Non-Governmental level or at both levels. These programs will be planned locally, directed locally, implemented locally and evaluated locally. The global components of Phase 3 provide support to the local groups.

The National Program will be Governmental, Non-Governmental, or preferably both Governmental and Non-Governmental. These will depend on the country and the mode in which developments are feasible but could be:

• a new policy for science and technology education;

• new curricula, implementation strategies, resource materials, assessment techniques for supporting formal, informal and non-formal learning;

• promotion of the need for and the status of science and technology education within the community using the formal school sector, the media, and greater community involvement;

• encouraging 'think and act' for greater scientific and technological awareness and literacy;

• promoting the need for greater concern for science and technology and in understanding the 'trade-offs' (good for some, bad for others!).

ICASE plans to actively support Science Teacher Associations (as important national NGOs) in assisting such programs.

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For further information contact:

Dr Jack B Holbrook
ICASE Executive Secretary
Department of Curriculum Studies
University of Hong Kong
Hong Kong
Science Education in Indonesia

by

John E Penick & Mohammed Amien

According to Leyden (1984), about 43 percent of high school graduates in the United States will go on to college. Similarly, in Indonesia, about 43 percent of high school graduates are admitted to higher education (Isman, 1985). But far fewer students complete high school in Indonesia; in 1983/84, only 25% of youth aged 16-18 were enrolled.

To improve education in Indonesia, a 1975 curriculum reform was supported by a series of in-service programs for teachers, administrators, school supervisors, and headmasters. The program was reported to involve more than 18,000 school personnel during the period 1976 to 1979. Further orientation programs for teachers were carried out by a 'cascade' method where the central office trained the regional instructors and the regional instructors conducted regional courses for the teachers. Eleven such regional centers were established.

Several additional steps have been carried out to introduce reforms in science education in Indonesia: (1) establishment of the free textbook program; (2) building of science laboratories and the provision of specialized equipment; (3) a new curriculum which stressed hands-on student activities; and (4) planning for more orientation courses to help administrators, supervisors, and teachers to become familiar with the aims of the science education reform.

Another reform in 1984, after the Minister of Education and Culture signed a decree (SK. No. 04861 U 1984) regarding the implementation of the '1984 Curriculum', established two Senior High School Programs, the Core Program and the Electives. The Core Program consists of 60% of the whole high school program and is worth 134 credit hours. Included is biology, 2 semesters, worth 6 credit hours, and 14 other courses (Dep. PDK, 1984). The Electives prepare students to pursue higher education and enter the career world. The Electives consist of 40% of the whole program or 88 credit hours. There are two kinds of Electives, the A program and the B program.

The A program serves the second goal of high school education, that is to prepare students to study in higher education, especially in the university/institute. There are five groups of studies in higher level learning, physical sciences (A-1 group), biological sciences (A-2), psycho-sociological sciences (A-3 group), and cultural sciences and religion (A-4 group). The biological sciences program, for example, prepares the students to study biological sciences in higher level learning, in areas like agriculture, fishery, animal husbandry, medicine, biology. The students in biological streams must complete 22 credit hours of biology in 4 semesters (4, 6, 7 and 5 credit hour each). The B programs prepare students who want to seek jobs after high school graduation or to enhance their skills in vocational work. Unfortunately, the implementation of the B programs has been postponed because there is still lack of school facilities to support these programs. The decision as to whether a student enters the A or B program in the third semester is based on the student's performance in core programs. After finishing the third semester, students can transfer to another program if they want to change.

Beginning in 1984, the Indonesian government decided to use a new system for selecting new university students (freshmen) at forty-five Indonesian public universities (state universities), including 'open university'. This system, SIPENMARU (Sistem PENERIMAAN MAHASWA baru) or UMPTN (Ujian Masuk Perguruan Tinggi Negeri) has two ways of selecting freshmen; one is by taking the SIPENMARU test or UMPTN test, and the other is without a test, by a so-called 'talent scouting method'.

Isman (1985), stated that the major trends and issues in Indonesian education recently include:

(1) universalization of primary education
(2) a well-balanced curriculum with regard to academic and personality development with relevance to societal and national needs
(3) introduction of more flexible programs
(4) continuing commitments to the eradication of illiteracy and the improvement of practical basic skills
(5) the provision of facilities for continuing education for care development and self fulfilment
(6) awareness of the necessity to improve the quality of education.

From Isman's statement we can infer that Indonesian education still lacks:

(1) universal primary education
(2) balance in the curriculum with regard to academic and personality development as well as relevance to societal and national needs
(3) flexible programs

It also implies that problems of illiteracy, facilities for continuing education, and awareness of the necessity to improve the quality of education still exist.

The Indonesian Minister for Research and Technology, Habibie, stated after struggling for ten years Indonesia has
succeeded in achieving high technology as mastered by the advanced countries (Caraka, 1986).

The goal of REPELITA (the Five-Year Development Plan) indicates that at the end of the sixth REPELITA by the end of the 20th century, Indonesia must be ready to start an industrial state. It implies that education relevant to meet the needs of that era should be provided.

The sixth of the five-year development plans, requires that Indonesia should have enough scientists, engineers, and other skillful personnel who have adequate knowledge in science and technology. But, the Improving the Efficiency of Educational Systems (IEES) Study in 1986 reported that manpower analysis evidence indicates that Indonesian labor has not yet reached the level of skill required for industrial expansion (IEES, 1986 p. 320). Indonesia's 12 year attempt to support an aeronautic industry (Caraka, 1986) has proven that Indonesia's manpower is reliable and ready. However, more and more experts and skillful personnel in science and technology will be needed as successors to those currently employed as well as for expansion. This requirement can only be fulfilled by early preparation through providing scientific and technological knowledge appropriate to solve the designated problems of the future.

To do this, Indonesian science education goals need expansion. Revising the existing curriculum becomes a must if the goals of science education are to be adjusted or achieved. The teaching approach should also be modified to meet the needs and appropriate assessments conducted to ensure the achievement of the new goals.

The sources of technology are moving rapidly, contrary to the Indonesian educational plan. For these reasons, it is reasonable to scrutinize the inadequacy of Indonesia's current science curriculum and develop a new set of goals and ideas.

Current Indonesian science textbooks required for precollege students contain little information on new technologies, even while some of these technologies are a part of students' daily lives. Changes in science and technology should be followed by Indonesian science educators to enable them to inform their students about the most current applications of knowledge.

The Indonesian secondary education is divided into two levels, the lower and upper secondary, along with another division, general and vocational stream. Each level consists of a three-year program of study, equivalent to grades 7-9 and grades 10-12.

Hidayat (1987) showed that there was a positive increment in the Indonesian students' positive perception toward science, career awareness, and the usefulness of science from elementary to senior high school. But it seems that this positive perception is not accompanied by a higher achievement in science courses at the precollege level. Professor Nasution, the former rector of Bogor Institute of Agriculture, stated that the quality of candidates who were entering Indonesia's public universities in 1988 were not better than those of the previous years (Binadja, 1988). Nasution is so concerned with the quality of science education graduates in Indonesia that he feels a special school needs to be provided for science students. Unfortunately, a study conducted by Susilo (1986) supported this statement. Her study indicated that the prerequisite knowledge of biology for science education graduates entering the university is lower than what is expected or needed. The lack of teachers' capabilities in teaching science could be one of the reasons for the low quality of science education graduates in Indonesia (Van den Berg & Lunetta, 1986). Some science teachers in secondary schools were graduated from Diploma Programs that take only one to three years to complete after senior high school. According to a UNESCO study (1986), Indonesia devoted 1.5 hours per week to science at grades 1-2, 2.2 at grades 3-6, and 3.2 at grades 7-9. In technology, Indonesia devoted 1.5 hours per week at grades 1-2, 3.0 at grades 3-6, but no data are available for grades 7-9. These values were at or below the average values for the world. The broadest goal of secondary education in the next decade must be to deliver to the nation a skilled pool of

1992 ICASE YEARBOOK
Science Technology Society

Edited by
Robert E Yager

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Department of Curriculum Studies, University of Hong, Hong Kong
manpower with the knowledge and competence to add a substantial new industrial base to the Indonesian economy.

The introduction of the Outline of Instructional Program for Lower Secondary School (GBPPIPASMP - Ind, 1986) stated that the goals and functions of science education are to enable students to:

(1) master scientific concepts and their interrelationships
(2) utilize scientific methods which are supported by scientific attitudes, to solve problems students face in order to realize the dignity and the power of the creator (God).

In addition, the Outline also stated the following functions of science courses:

• to develop skills to gain, develop, and apply scientific concepts
• to develop (personal) attitudes and values
• to implant scientific attitudes into the students and train them to scientifically solve problems they face
• to make students aware of the importance of maintaining the environment and natural resources
• to make students aware of the order of the universe, its beauty, in order to appreciate and glorify the creator
• to provide students with basic knowledge for continuing their education to a higher level and apply it in their daily lives
• to develop students' intellect and creativity

The major goal of senior secondary education is successful preparation for further academic study at the university.

IEES (1986) study indicated that many schools report that for a variety of reasons they find it difficult to complete the full scope of the curriculum, including the science curriculum. There is a gap in the operational curriculum between what is intended and what is accomplished.

In practice secondary classes are organized in set groups of students. Teachers come to the class; students do not move except for laboratory courses. Classes range in size from 40 to 50 students. The gross ratio of students to teachers is about 15.4:1, while the face to face student/teacher ratio is 42:1. Face to face ratio is the actual ratio of the average number of students in a class taught by one teacher. The face to face ratio is more important than the gross ratio because this ratio represents the reality of a full-time teacher handling full-time students in approaching an international standard. It is not unusual, however, that a teacher teaches a class consisting of 50 students. Most classes are designed to accommodate 50 students.

The average class size in lower secondary school is 45. A group of students is assigned to the same class for instruction for one year and often for the entire three years of their time in the lower secondary school. The ratio of students to teachers in lower secondary school is approximately 18.9:1. But it must be noted that most of the 115,000 part-time teachers working in the private sector are double counted because most of them are also full-time teachers in public schools. It means that in reality the ratio may be greater than what is stated above.

In the lower and upper secondary schools the main textbooks for science classes are provided by the Ministry of Education and Culture. However, teachers are allowed to use other textbooks provided the textbooks cover the themes specified in the course content outline, and/or for enrichment purposes. The content is directed toward pure science practice rather than daily practice. Unfortunately, this means assignments that relate to inquiry methods are directed rather than letting the students use inquiry methods.

The current secondary level science curriculum, introduced in 1984, was also called the 1974 Update Curriculum. The total curriculum was officially put into action in the 1987-88 school year. The current curriculum, for upper secondary schools, offers the core and optional program (KurSMALPP-Ind). The core program is intended for students who plan to continue their education to the university level. The science core courses offered are biological science, chemistry, and physics. An optional program was designed for students who pursue a specific career after completing the secondary education.

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500 years ago, Christopher Columbus sailed three small craft – the Nina, the Pinta and the Santa Maria – across the blue Atlantic Ocean of our planet to discover a new world. 35 years ago, Russian technologists surprised the world by launching Sputnik into the heavens beyond this Earth’s atmosphere.

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**ICASE and ISY**

The ICASE contribution to ISY is through two international projects:

**Resource Materials for Science Teachers**

Dr David Moore, ISY Project Officer for ICASE, is coordinating the production of a set of resource materials for teachers, in collaboration with the ICSU Committee on Teaching of Science. For further information, contact:

Dr David Moore  
ISY Project Officer, ICASE  
ASE Headquarters, College Lane  
Hatfield, Herts AL10 9AA, UK

**ICASE World Activity Day**

**Thursday 14 October 92**  
**Theme for 1992: Space**

Teachers and students in schools around the world are invited to participate in special activities focusing on the theme of space. Thursday 14 October 1992 is designated as ICASE World Activity Day. Member associations of ICASE are requested to encourage schools in their countries to share in this worldwide program on 14 October. The activities, which can be adapted to suit students at all primary and secondary levels, include: (1) Designing, constructing and testing rockets which operate on compressed air and water; (2) Calculating the Earth’s diameter by measuring the length of the shadow cast by a stick; and (3) Writing a short essay (maximum 1000 words) on (a) space travel in the year 2092 or (b) life as a student in 2092 as a result of space technology.

See the March 1992 Issue for an outline of these activities. For further information, contact: Brenton Honeyman, ICASE Journal Editor, 10 Hawken Street, Monash ACT 2904, Australia.
Second ICASE Symposium 
Education Industry Liaison

by Jan Hendriks
ICASE European Regional Representative

As announced in the December 1991 issue of Science Education International, the very successful symposium in Brussels in September 1990 which was organised by ICASE in conjunction with the European Chemical Industry, will be followed by a Second Symposium on Education Industry Liaison.

AKZO, one of the leading chemical and pharmaceutical industries in Europe, has offered to host this Second Symposium during two days at the end of November 1992. AKZO has recently joined the ICASE network as a Company Member (refer to ICASE News). The Second Symposium will be held in Arnhem, the Netherlands.

The themes of the Second Symposium will include:

- AKZO Education Industry Partnerships and Projects
- Evaluation and experiences from other education industry partnerships
- Extension of the scope of education industry interfaces with publishers, press, television, education museums, etc
- Followup activities (eg workshops)

Participants will be required to cover their own travel and accommodation expenses.

Participation will be by invitation only. Those interested in Education Industry Liaison and, in particular, Education Industry Partnerships, are invited to submit a letter of application. Letters of application should outline the applicant's interests and experiences in the field of education industry liaison.

Letters of application should be sent before 1st July 1992 to:

Jan Hendriks
ICASE European Representative
Konijnendal 3
7921 BM ZUIDWOLDE (DR)
The Netherlands
Fax 31-5287-2693

Successful applicants will be selected by the Organising Committee and invited before the end of July 1992.

Copies of the proceedings of the first symposium on Industry Education Liaison can be ordered from ICASE at a cost of US$7.50 or £4.50 plus 25% postage.

A New Approach to Teaching Science In Russian Secondary Schools

by Dr Vjacheslav M. Dushenkov
Moscow Pedagogical State University

Russian society is following the way of changes. The education system is a mirror reflecting this process of change.

Arising out of a school system where the ideologies are as one and where all educators are required to teach all students according to one program on any subject without attending to the various abilities and interests of students, there emerges a new approach. Until recently, a future novelist, a future industrial worker, a future manager, and a future biologist all studied the one science curriculum and science program. Now there are various types of schools and classes, and various curricula are being developed. This new approach needs new programs, courses, textbooks and new teaching strategies.

In recent decades, humankind has become an increasingly disruptive influence on a global scale. The survival of our civilisation and the whole planet depends upon whether or not our children will be educated so as to become ecologically literate. Our children need to be aware of the inter-connectedness of all levels of life, of living beings and non-living matter, of humankind as an integral part of the environment.

At present, we are establishing a recognition that the 'environment' is not 'out there' but everywhere! It is the
Entire context of our lives.
Environmental education provides the large picture of the interconnectedness between biology, technology and culture – much larger than these studies provide separately.
Environmental education is comprehensive and global. It can provide an education which includes the 'big picture' enabling us to make sense out of our 'jigsaw puzzle' world.

This goal – to provide an education with the 'big picture' of the world – is becoming more and more critical.

As a result of industrial growth after World War II, there was a great movement towards the cities. Many children grew up without a deep knowledge of the natural world. They experienced smog, dead lakes and dumps, but did not appreciate the beauty of young green leaves or the charming songs of a nightingale. Their lives did not connect with nature, its sustainability or its health. Hence they were not aware of it; their behaviour reflected the way they think about the environment. The primary focus of any environmental education program must be, therefore, to change the way people think about their relationship to the world in which they live. They must recognise that the global ecological system is essentially a single, integrated life support system, and that all of our natural and cultural systems are interconnected and interdependent.

Educators are challenged by the goal to develop an environmental program which integrates nature, culture, technology, people, ideas and feelings. This challenge has encouraged a group of Russian pedagog to try and develop such an integrated program for 5th to 7th grade children. The course was entitled General Science.

Why were these grades selected? In our school system, children begin school when they are 6 or 7 years old. They are taught for 3 or 4 years at primary school; during these years, they undertake a course entitled 'Environment'.

Environment Course
The main goals of this course are to:

- develop an appreciation of nature and phenomena of social life in order to understand the connections within the system 'humankind-nature-society'
- develop a comprehensive understanding of our own bodies, and the necessity for personal and social hygiene
- form an appreciation of moral and ethical norms of behaviour accepted within society towards nature, environments and people
- foster an interest in life, nature and social phenomena in order to develop an attitude of complicity, duty and care toward nature and people

The content and structure of this course has been developed with consideration for children's psychology in the 6-10 year age range which perceives the surrounding world as a whole. This is why the course includes both the habitant and social environment together so as not to hinder the formation of the notion of integrity of the whole environment.

For each grade, the Environment course units are as follows:

**Second Grade (68 hours)**
Unit 1 - You are a pupil of 1st grade
Unit 2 - Your health
Unit 3 - We and things around us
Unit 4 - Nature around us
Unit 5 - Native country

**Third Grade (68 hours)**
Unit 1 - Man and his health
Unit 2 - What surrounds us
Unit 3 - My friends: adults and children
Unit 4 - Man and nature
Unit 5 - Native country

**Fourth Grade (68 hours)**
Unit 1 - Introduction
Unit 2 - Man studies environment
Unit 3 - Locality in the region of school and its features
Unit 4 - Forms of land surface
Unit 5 - Natural sources
Unit 6 - Water and its role in nature and man's life
Unit 7 - Air and its significance for nature and man's life
Unit 8 - Natural and artificial communities

Unit 9 - People on earth
Unit 10 - The Earth as a space body

From 5th Grade, children begin secondary school. The General Science course was developed as a sequel of the Environment course.

General Science Course
The goals of this course are to:

- master scientific facts; notions; symbols; generalisations of physical, chemical and biological phenomena; their interrelations as the basis of nature
- form a scientific world outlook; knowledge about nature as a developing system
- develop knowledge of ecology, the role of people in nature, and of humankind as part of the biosphere
- develop a familiarity with the structure of the human body, the measures directed towards health protection, hygienic standards, hygienic and sexual education, formation of a healthy lifestyle
- focus on the significance of the natural sciences in the national economy and in conservation of nature
- develop creativity, ability to think logically, memory, speech, imagination, and observation skills
- cultivate emotions and feelings, will and persistence
- develop cognitive skills (ability to analyse and compare, to make conclusions, to explain phenomena) and practical skills (ability to use equipment, to conduct experiments)

The course is divided into three parts – one part per year. Three versions of the General Science 5-7 course were proposed. The one described here is entitled 'Nature and Man'. This course is appropriate for different types of schools and encourages a new way of thinking by focusing on global environmental problems.

**Part I - Fifth Grade**
The first part is devoted to the Earth as part of the Solar System; bodies living and non-living and substances on the Earth (molecules, atoms, elements in living and non-living bodies, spheres of the Earth); diversity of living beings on the Earth; man as a natural and
social being. This part provides the answer to the question "What can we find on the Earth?": The major thrust of this part is the interconnection of all bodies on the Earth, of living and non-living things.

Part 2 - Sixth Grade
The second part is devoted to all natural phenomena – physical, chemical, geographical, biological and social. Children study power, electricity, light, sound, and chemical reactions in nature, shaping these phenomena as environmental factors influencing living beings. Biological phenomena are shown through metabolism. Different types and processes of nutrition, respiration, excretion, reproduction, development and irritability are examined in plants and animals. Students learn about anatomy and the morphology of different living beings through the functions of these structures in metabolism. The final unit – social phenomena – shapes the role of mankind on the planet.

Part 3 - Seventh Grade
The third part focuses on natural systems, their connectedness, and development. The first unit is devoted to the system 'matter-energy' as a universal system. The second unit describes ecological systems – populations, communities (natural and human made), ecosystems, their structure development and responses to stress. The third unit is about the Earth's development as a global ecosystem. The unit 'Man and different systems' ends the course.

In all grades and throughout all units, science, art and folklore are incorporated in the same way. The course features poems, proverbs, and sayings about nature and its phenomena. Pictures by great artists illustrate textbook pages (for example, when explaining light phenomena, the problem of light distribution in the pictures of the impressionists is

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**An Invitation to Kansas City**
**NSTA National Convention**
**March 1993**

**International Round Table**

Each year at the NSTA National Convention, the International Committee of the United States National Science Teachers Association (NSTA) hosts an International Round Table. At this 90 minute session, presenters from different parts of the world discuss their country’s science education programs.

Each presenter is provided with a table for a materials display. Those attending the International Round Table session visit the tables of countries they wish to learn about.

If you would like an official invitation to participate as a representative of your country, write to:

John E Penick  
Science Education Centre  
Room 789 VAN  
The University of Iowa  
Iowa City, IA 52242-1478  
USA

Participants will be required to arrange their own funding. The letter of invitation, and your name listed in the program, may help you as you seek funding support.

For information about other conferences refer to the Calendar section in this issue.
discussed).

When discussing the scientific problem of the origin of the Earth and life on it, some pages focus on science fiction literature, and on ancient legends and myths about this topic. The course describes how various nations have tried to recognize and explain this problem during the centuries. Hence, the course develops an understanding that science and art, science and social studies together lead us to a holistic view of our environment.

After the 3 year course ‘Man and Nature’, biology, chemistry, geography, and physics are studied for two years as separate subjects. Some students who are interested in science continue their education in this field. Those who don’t will have a new course ‘General Science 10-11’ to study – a new course which is under development. We would welcome other pedagogues joining us in this exciting work.

For further information, contact:
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Kibalchicha 6, Building 5
129278 Moscow
Russia

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Report: 1992
NSTA National Convention

by Dr Ken Roy
ICASE North American Representative

Boston was the site for the National Convention of the National Science Teachers Association on 26-29 March earlier this year. This convention was the largest in the history of NSTA with over 18000 teachers, administrators, professors and others in attendance.

Available for participants were tours, short courses, expositions of science teaching materials, publication sales, seminars, affiliate-sponsored sessions and presentations by educators.

Special seminars were offered, including:
- Remote sensing of the Earth environment by Farouk El-Baz of the Center for Remote Sensing in Boston
- Building living ecosystems by Walter Adey of the Marine Systems Laboratory, Smithsonian Institution
- Advances in human genetics: recent discoveries and their implications by Aubrey Milunsky of the Boston University School of Medicine
- Global environmental change by Eileen L Shea of the National Oceanic and Atmospheric Administration
- Cancer connections: the food that we eat or the air that we breathe by Gary W Winston of the Department of Biochemistry, Louisiana State University
- Space and time: from Newton to Einstein and beyond by Abhay Ashokker of the Department of Physics, Syracuse University
- Paradigms for research and parables for teaching by Dudley Herschbach of the Department of Chemistry, Harvard University

There were over 1000 presentations on a variety of topics for Kindergarten teachers through university graduate school professors. Presentations focused on the issues of the day for practitioners in the United States. These included major national curriculum initiatives such as Project 2061 (AAAS); Scope Sequence and Coordination Project (NSTA); business education liaisons; funding; elementary programs in science education; computer interfacing; chemical safety; performance assessment techniques; hard core science; interdisciplinary science; trade books for elementary science; and much more.

Several ICASE activities were planned and held. Included were:

At the ICASE Executive Meeting, discussions were held with ICASE President Bob Lepischak, Executive Secretary Jack Holbrook, Special Projects Officer John Penick, and North American Representative Ken Roy.
ICASE President Bob Lepischak and North American Representative Ken Roy attended and represented ICASE at the NSTA International Committee meeting. ICASE Special Projects Officer Professor John Penick served as the chairperson of the Committee. Dr Gerald Krockover of Purdue University was named as the new chairperson of the International Committee.

The featured speaker for the ICASE International Luncheon was Professor Gerald Krockover of Purdue University. His presentation was titled Science Education: Reflections of the USSR.

At the CASE/ICASE Breakfast, the featured speaker was Dr Jack Holbrook, Executive Secretary of ICASE. He spoke about the Project 2000+ Conference which will be held in Paris, France during July 1993.

An ICASE exhibit booth was erected to share publications and international opportunities with participants.

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The STS Approach Parallels Constructivist Practices

by Robert E Yager

Science Technology Society (STS) is defined by the National Science Teachers Association (NSTA) as the teaching and learning of science/technology in the context of human experience. Eleven features are offered by NSTA to describe STS approaches to teaching (NSTA, 1991). These features include:

1. student identification of problems with local interest and impact;
2. the use of local resources (human and material) to locate information that can be used in problem resolution;
3. the active involvement of students in seeking information that can be applied to solve real-life problems;
4. the extension of learning going beyond the class period, the classroom, the school;
5. a focus upon the impact of science and technology on individual students;
6. a view that science content is more than concepts which exist for students to master on tests;
7. an emphasis upon process skills which students can use in their own problem resolution;
8. an emphasis on career awareness, especially careers related to science and technology;
9. opportunities for students to experience citizenship roles as they attempt to resolve issues they have identified;
10. identification of ways that science and technology are likely to impact the future; and
11. some autonomy in the learning process (as individual issues are identified).

The Constructivist Learning Model is advanced as an explanation of how learners learn. Von Glaserfeld is one of the foremost constructivists who has offered the experimental, philosophical, and research base for constructivism. The model invites certain teaching approaches. These include:

1. seeking out student ideas before presenting teacher ideas or before studying ideas from textbooks or other sources;
2. encouraging students to challenge each other’s conceptualisations and ideas;
3. utilising cooperative learning strategies which emphasise collaboration, respect individuality, and use division of labour tactics;
4. encouraging adequate time for reflection and analysis;
5. respecting and using all ideas that students generate;
6. encouraging self-analysis, collection of real evidence to support ideas, reformulation of ideas in light of new experiences and evidence;
7. using student thinking, experience, and interest to drive lessons (this means frequently altering teachers’ plans);
8. encouraging the use of alternative sources for information both from written materials and live ‘experts’; and
9. using open-ended questions.

STS certainly has a curricular dimension. In fact, some refer to STS themes, topics, and courses (Bybee, 1986; Rubba & Wiesenmayer, in press). However, the curricular dimension does not distinguish STS from any other course or unit that may be offered to meet innovative goals. The instructional approach required of STS (see NSTA listing above) provides the explanation for the successes commonly reported for STS instruction (Yager, in press-a, in press-b).

The Project Synthesis research team offered a contrast of the instructional procedures found in a typical science class and those which would characterise an STS classroom. The list of strategies that should characterise an STS classroom also describes teaching techniques required for teachers interested in creating a classroom where constructivist practices can be seen. Table 1 (refer to following page) provides a list of these contrasts.

When STS instructional strategies are employed, student learning is enhanced. The mastery of student concepts is no better than it is in typical classrooms. However, significant advantages in favour of STS instruction occur in terms of student understanding and use of process skills, ability to use basic science concepts and processes, creativity skills (quality and quantity of questions, explanations, and prediction of consequences), and more positive attitudes concerning science classrooms, teachers, and careers. Figure 1 illustrates composite results which show student learning that has been measured in classrooms of Lead Teachers in the Iowa Chautauqua Program (Blunk & Yager, 1990).
### Table 1

**A Contrast of Typical and STS Teaching Strategies**

<table>
<thead>
<tr>
<th>Typical</th>
<th>STS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teachers work in their classroom with several sections of students assigned to them.</td>
<td>Teachers work as part of a staff team working toward common goals.</td>
</tr>
<tr>
<td>Teachers feel tied to a textbook and/or a curriculum guide.</td>
<td>Teachers look beyond the boundaries of a textbook and/or curriculum guide; they define minimal concept and activities used.</td>
</tr>
<tr>
<td>Teachers are discipline bound; they rarely work competently with teachers from other curriculum areas – or science teachers from disciplines other than their own.</td>
<td>Teachers are constantly seeking linkages with others in the total school; they also seek linkages with other teachers in the state and nation.</td>
</tr>
<tr>
<td>Teachers tend to distrust the use of experts from the community (external to the school).</td>
<td>Teachers see themselves (and their students) as reaching into the community for information, expertise, ideas, and materials.</td>
</tr>
<tr>
<td>Teachers are seen as dispensers of information they possess.</td>
<td>Teachers are seen as learners themselves and as facilitators and collaborators in student learning.</td>
</tr>
<tr>
<td>Teachers rarely think about goals for science teachers; they rarely enter into debate or meaningful dialogue about their teaching.</td>
<td>Teachers are anxious to share their philosophies as they seek ways of expanding their thinking; they seek information that will help them improve teaching.</td>
</tr>
<tr>
<td>Teachers complain about in-service learning opportunities</td>
<td>Teachers seek out in-service assistance as they seek to grow and to improve.</td>
</tr>
</tbody>
</table>

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Dr. Jack Holbrook, Executive Secretary
Department of Curriculum Studies
University of Hong Kong, Hong Kong

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**Eighth ICASE Asian Symposium**

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**Science Education for a Changing World**

Contact:
Mr. Asoka Weerasinghe
Hon Joint Secretary, SLASME
Institute of Computer Technology
PO Box 1490, Colombo
Sri Lanka

Organised jointly by ICASE and the SLASME
The advantages of STS instruction likely occur because of the validity of the Constructivist Learning Model. The essential strategies that characterise STS teaching parallel the teaching procedures demanded by constructivism. If STS and Constructivist approaches are to achieve the potential envisioned by proponents, the reforms for which so many yearn will be realised. It will mean completely new roles for science teachers. These new roles will demand a teacher education vastly different from that found in most colleges and universities. It will require more experiences with STS and more opportunities for would-be teachers to structure their own meaning. It will require less remembering what students are told and more practice with questioning and personal actions as prospective teachers learn to deal with their own questions and how to learn to develop even better ones. These are skills that teachers must foster in their students - a task that many find threatening - even impossible without some experience in doing it themselves.

References
Yager, R E (Ed) (in press-b) The status of science technology society reform efforts around the world Hong Kong: International Council of Associations for Science Education
Yager, R E, Blunck, S M & Ajam, M (Eds) (1990) The Iowa assessment package for evaluation in five domains of science education Iowa City, IA: The University of Iowa

About the author
Robert E Yager is Professor, Science Education at the Science Education Center, The University of Iowa, 769 Van Allen Hall, Iowa City, Iowa 52242
The Role of the Teacher in an STS Classroom

by John E Penick & Ronald J Bonnstetter

Teachers do make a difference and the STS classroom is no exception. Several studies of teachers in STS settings have revealed ten generalisations about their role. Effective and successful STS teachers:

Provide a stimulating, accepting environment

Students do best in an environment rich in human and material resources combined with numerous opportunities to initiate, study, and take action. Effective teachers do this by scheduling time for individual as well as group work and by expecting action, not just words or reading. Teachers encourage student decision making and action by not being content with mere knowledge and reports. Students can and will go a step further toward action if their teachers expect and encourage it.

Have high expectations of themselves and students

In addition to expecting students to go a step further, good STS teachers want these steps to lead to change. Change may be in learning or it may be resolution of a real problem. Teachers have different expectations as well, recognising that students have varying potential and that a student may perform quite differently in the STS situation. These high expectations carry over to the teacher as evidenced by their continual push to do more, gain more involvement, and see more resolution. Teachers with high expectations also see their role as more than a teacher of thirty students. They see their role as a larger one in a community context and as a model of active enquiry.

Are models of active inquiry

Exemplary STS teachers bring inquiry alive by presenting themselves as students, eager and willing to learn new ideas, skills and actions. By bringing new ideas to the class, by questioning and being open minded, these teachers are clearly models to be followed. They also model the thoughtful and rational approach to problem identification and resolution by being interested, seeking information, asking for evidence, and by taking action themselves. In essence, they are making their thinking, feelings, and approach to learning highly visible.

Expect students to question facts, teachers and knowledge

By making their approach visible, students easily see that science involves a degree of skepticism, as Richard Feynman put it, "a belief in the ignorance of experts". Not an assumption of being wrong, such a belief is a quest for evidence to support a fact, idea, or position. Students who have questions, seek answers, and who can provide evidence become active citizens with the same attributes. Certainly, these are the core of science literacy.

Stress science literacy

Teachers stress science literacy by demanding a rational and independent approach to science. Students are expected to seek, to question, to explain, and to apply their knowledge. Teachers are not content with just knowing words or skills, they insist that words be used to justify, defend, or clarify larger concepts or actions. Students must apply their knowledge before it truly becomes a part of them.

Want students to apply knowledge

Applying knowledge may be answering questions at the end of the chapter. But, effective STS teachers are never content with this alone. Calculating vectors in a pulley system does not have as much potential or is not as problematic for most students as does actually rigging a block and tackle. The same is true with societal applications where students seeking justification for a new community water treatment plant view their learning as vastly different than reading a standard text on the subject. In both instances, they can see their knowledge as it is being used, often outside the classroom.

Do not view the classroom walls as a boundary

Teachers want students and learning to go beyond the classroom. Any learning that is real must, by definition, continue with the student into the rest of their world. Obviously, these effective teachers see that both their students and their ideas have many opportunities to go beyond the classroom, via field trips, visits to resource persons and facilities, and using outside materials such as books, papers and ideas. At the same time, teachers invite community experts in, through the walls, offering new insights and perspectives on existing problems and often raising new ones.
Are flexible in their time, schedule, and curriculum

Bringing in outsiders is quite disruptive. Students find new ideas to pursue, old issues get sidetracked, and the teacher loses some control. And, an effective teacher takes advantage of this, changing as opportunity presents itself. Students learn but not always as the teacher anticipated nor on the same schedule. But, the stimulation, excitement and involvement lead to many new avenues of motivation and learning – for the teacher as well as the student.

Put in far more than the minimal time

Scheduling, shifting, coordinating, expecting, and planning all require time. We find that teachers in exemplary STS programs worry about time but focus that worry on finding more to devote to their classes and ideas. They tell us what time they have is fleeting, the days are not long enough to contain all they want students to be involved with. As a result, they put in hours after school and on weekends, striving to make their teaching all it can be.

Teachers do make a difference

While national assessment data indicate most students don’t like science, students from classrooms where teachers exhibit these generalisations feel differently. They like science, science teachers, and science teaching. They feel science is useful, now and in the future.

Effective teachers cause students to see uses for their science and give them confidence in their own ability to use and be successful with science. And, these teachers are eager for Monday morning.

These are the teachers we wished we had had and whom we continue to want for our children.

Teachers do make a difference and the STS classroom can add even more.

---

Pasteur and Microbes
A Teacher Resource Book

Commemorating the 100th Year of the Pasteur Institute
1888-1988

This valuable resource book (166 pages) provides information about the activities and facilities available at the Pasteur Institute. It contains a variety of science experiments relating to the action of soil microbes, yeast as a food-making microbe, micro-organisms in milk, making cheese, making vinegar, and making wine, to name just a few.

These activities are appropriate for secondary science teaching. Emphasis is on useful micro-organisms, food production and food preservation.

Order by sending a cheque (payable to "ICASE") US$8.00 or £5.00 (add 25% postage and packing) to:

Dennis Chisman
Hon Treasurer ICASE
Knapp Hill, South Harting
Petersfield GU31 5LR, UK
### TABLE 1

**How to be an effective teacher**

**Provide a safe, stimulating, accepting environment**

The classroom must be rich with books, magazines, newspapers, art, equipment, and artifacts. Equipment should be readily available for spontaneous use (often students don't know they need something unless they see it).

The teacher must stimulate with provocative and insightful questions and statements then, to encourage students, allow sufficient wait time and accept (with no evaluation) all responses. Rather than "good" or "No I don't think so", nod, say "OK what else", or get additional students to respond. Students must feel safe if they are to risk something new. It's never really safe if someone is evaluating you.

**Have high expectations of yourself and students**

Don't be content with last year or the norm; always go at least one step further. Let students know you have faith in them when they produce a report, go further and send it to your local newspaper. Don't grade on a curve.

**Be a model of active inquiry**

Bring in questions from your own observation, reading, and conversation. Take action to find out new resources and information. Be a learner. Let your students know you don't already know everything. Show your curiosity.

**Get students to question facts, teachers and knowledge**

First it must be safe. Then raise questions yourself, ask always for evidence supporting assertions or ideas. Put yourself in positions where students can successfully challenge you. Be willing to learn alongside them (see above). Play 'devils advocate', raising issues and questions even if you know them to be false.

**Stress scientific literacy**

Students who see you and themselves engaged as described above, will see and experience science as an active process of thinking and doing. As a result, they will come to rely on and expect their science to be useful personally.

**Get students to apply knowledge**

Use real-world problems and encourage your students to find other examples in their own lives. Provide time to discuss applications and evaluate these applications as well. Visibly apply knowledge yourself as you expect them to do the same.

**Not view classroom walls as boundaries**

Information as well as students flow in and out; take advantage of it. Reward students who bring ideas and information in and take solutions out. Do the same yourself by bringing in people and materials as resources; schedule group field trips and encourage individual students to make their own field trips. Teach students to use the library, write letters, and telephone sources. Get parents involved in the classroom and out of it as well.

**Be flexible**

Lesson plans are not religious documents. Feel free to postpone, ignore, change or delete. Watch for 'teachable moments' when you and your students can move ahead as learners. Use current events as they happen and help students to be 'investigative reporters'. A flexible student or teacher follows leads as they happen, not when scheduled.

**Put in more than minimal time**

Then, be more efficient; get students to do more of the work. We know of many classes where the students really do the lesson planning while the teacher plans the learning environment. But, it still takes time to develop your organisational plan and to have materials ready.

**Make a difference**

Trust yourself and your students. Look inward and ask "Is this best for my students and goals?" Study exemplars and most of all, study your teaching, making changes for the better. Your students will notice and appreciate your efforts.
The Infant Pedagogic Centre
in Antigua

by Sue Dale Tunnicliffe

The Infant Centre celebrated five years of existence in April 1992. It was set up following the infant co-ordinator's study leave in Israel. The philosophy is soundly rooted in the child as an active learner and acknowledging the experiences and knowledge which the youngster brings to his or her schooling.

Now in its second location, Newman Street, a short walk from the Ministry of Education itself, the centre has an office room and a front room which acts as a workshop room too. In these rooms are kept all the equipment.

Of particular note is the Science Centre Area which contains suggestions for classroom displays and activities and sourcebooks for the teachers to look at. In their recent publication *Ideas to Share* (Vol 2 No 8), the Centre shared ideas about setting up a science centre. These are reprinted here.

Most of the equipment in the Antigua Science Centre is low cost and locally available, including disposable plastic beakers, stirrers and sugar sachets from local hotels and catering containers from local airlines.

For further information, contact:
Sue Dale Tunnicliffe
Project Officer
ICASE Stepping into Science Project
18 Octavia, Bracknell
Berkshire RG12 7YZ
UK

Establishing a Science Centre
Reprinted from *Ideas to Share* April 1992

A Science Centre is designed to provide children with the opportunity to learn about their world through investigation of what may be found in the school or home environment.

The materials and equipment in the Centre could be related to a particular theme or program, or they could be of general use, for other science activities carried out by teachers and children.

It is important to make observations, discuss processes, make predictions, and note outcomes. Children should look for and find the answers; the teacher should not tell them, but should act as a resource to help children think through and decide for themselves.

Every infant classroom should have a Science Centre where the child can:
- observe collections of objects and collections of pictures
- learn their names and normal usage
- handle them and observe them
- repeat the experiments the teacher has performed with the class
- experiment on his/her own
- display the collections he/she brings to school, and put away afterwards
- keep and take care of small animals such as fish, turtles, snails, crabs
- use his/her five senses – sight, hearing, touch, smell, taste

In setting up and presenting the Science Centre, the following needs to be considered:
- Provide the equipment, space and time for children to repeat the experiments themselves.
- Put up a bulletin board with pictures or objects related to the display.
- Have a place outdoors where children can sow seeds, dig, observe insects, etc.
- Have science materials children can touch, feel, listen to, and even taste.
- Science equipment should be simple and inexpensive.
Necessary supplies and equipment include:

- Collections of specimens from nature: pebbles, birds' feathers, shells, sea coral, seeds, seed pods, leaves, cones, coconuts, caterpillars, tree bark, insects, bird nests, bulbs, plants, tortoises, etc.
- Instruments for experimenting: magnet, magnifying glass, pulley, thermometer, balance, mirror, prism, clock, weather vane, barometer, bicycle pump, straw, wire, see saw, corks, nuts and bolts, measures, containers of water and sand, etc.
- Household materials which can be adapted for experimentation and for scientific observation: empty jars for terrarium or aquarium; jars and boxes of different sizes and shapes (glass, plastic, aluminum, foam and cardboard for observation boxes and planting seeds; see-through plastic for covers; pieces of rubber tubing for siphons; sponges, cotton wadding and blotters; cheese cloth and piece of wire for a net to catch insects; containers, pie plates and cake pans for experiments; combs, silk, woollen and fur fabrics for experiments and handling (also for static electricity); spools, string and wire for pulleys; salt, sugar, vinegar, soda, cloves, lime, flour, cornstarch for flavours and constructions.

Science activities

Science activities which foster the development of observation and an understanding of causal relationships:

- Leaf collection: press and preserve, play with dead leaves, rake them, pile them, make leaf prints with paint.
- Collect seeds: sort them, plant some, make seed pictures.
- Take care of plants: observe their growth, record in pictures and words.
- Observe birds and flowers for likenesses and differences: use pictures too.
- Prepare and observe plants which grow in a big terrarium bottle.
- Examine a collection of shells: sort them in many different ways - by colour, by size, by those alike and different, by broken or whole, by one part or two.
- Observe the sky and clouds for changes.
- Hold cloth up into the wind: observe and make comments, make a wind sock.
- Observe the sea and the waves: record daily for a week, with pictures.

More science activities

- Look at self in mirror. What do you see? Touch tip of nose, top of head, one eye, one ear. What do you see?
- Close eyes. Feel four objects. Comment on how they feel - smooth, cold, rough, furry, soft?
- Hold three objects which are arranged in order of heavieness, then lightness.
- Make two sets - living or non-living - from pebbles, toy car, seeds, rubber, sand, wooden block, flower, leaf, spoon, etc.
- Match babies to their adults using picture cutouts or toy animals - cat and kitten; calf and cow; chick and hen; etc.
- Name shapes - triangle, square, circle, rectangle. Explore classroom and schoolyard for like shapes. Record them. Make pictures of them.
- From a few different flowers, see which have smells and which do not. Compare colours and smells. Do the same kinds of flowers have the same number of petals?
- Describe the odd one out in sets (eg same colour pencils but one differs in length; nails and one screw; limes, one larger; shoes, one boot, etc).

Photos below show teachers at the Science Centre in Antigua
Activities Book
The Stepping into Science Project is planning to produce an Activities Book as a resource for primary/elementary teachers of science. If you have activities to contribute for publication in such a book, or in the Stepping into Science Newsletter, please forward to:

Sue Dale Tunnicliffe
18 Octavia
Bracknell
Berkshire RG12 7YZ
UK

ICASE Stepping into Science
Come and Share
ASE Annual Meeting
January 1992, Sheffield, UK

Photo (right): Floating a fish!
One of the activities at the ICASE Stepping into Science session 'Come and Share' held at the ASE Annual Meeting in Sheffield, January 1992.

Photo (left): Yunus Sola attempts to make a needle stand up at the ICASE Stepping into Science 'Come and Share' session.
Stepping into Science
An ICASE Primary/Elementary Science Project

AIMS
Stepping into Science is an ICASE project which aims to:

• Establish an international network for teachers to share ideas on the teaching of primary/elementary science and technology.
• Provide activities and support for teachers, thereby encouraging them to include more science in the primary/elementary curriculum.
• Promote the value of science experiences for young children throughout the world.
• Facilitate professional development opportunities for teachers by including sessions on primary science and technology in regional and international conferences.

ACTIVITIES
The Stepping into Science Team is actively involved in a number of projects and activities including:

• Publishing STEPS, the Stepping into Science Project Newsletter. This newsletter contains ideas for class activities at various levels in primary/elementary schools, activities for children to do at home, comments by network members on issues, examples of children’s work, lists of helpful resources and contacts. ICASE acknowledges the contribution of Philip Harris in sponsoring STEPS.
• Contributing articles and ideas for the Primary Science Section in Science Education International, the ICASE quarterly journal.
• Compiling ideas and activities for inclusion in a series of sourcebooks on the teaching of primary/elementary science and technology.
• Coordinating a scheme to encourage children to participate in science and technology activities. Certificates of Participation have been produced, and are available for schools to use in rewarding students as they complete a number of activities. Certificates are colour coded in seven different colours, so that they can be used to acknowledge progress in science from early to advanced levels within primary/elementary schools. ICASE is grateful to BP (Oman) for sponsoring this scheme.
• Organising Stepping into Science workshops and displays of children’s work at national, regional and international conferences.

FOR MORE INFORMATION
Contact the Project Officer:
Sue Dale Tunnicliffe
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Stepping into Science Project
18 Octavia, Bracknell
Berkshire RG12 7YD
United Kingdom
More Activities to Investigate Principles of Rocketry

World Activity Day
14 October 92
Celebrating International Space Year
in schools around the world

Teachers and students in schools around the world are invited to participate in special activities focusing on the theme of space. Member associations of ICASE are requested to encourage schools in their countries to share in this worldwide program on 14 October. The activities, which can be adapted to suit students at all primary and secondary levels, include:

1. Designing, constructing and testing rockets which operate on compressed air and water

2. Calculating the Earth’s diameter by measuring the length of the shadow cast by a stick

3. Writing a short essay on (a) space travel in the year 2092 or (b) life as a student in 2092 as a result of space technology

See pages 27-30 in the March 1992 Issue of Science Education International for an outline of these activities. Member associations are encouraged to reprint these pages in their own journals and newsletters to encourage schools to participate.

In the March Issue of Science Education International, this column introduced some activities on the theme of space science. One of the activities Up Up and Away with Bottles challenges students to design water rockets which operate with compressed air and water. As a result of the interest in this activity, two further articles are included on this topic – The Sparklet Rocket and Newton’s Third Law and Extensions to the Bottle Rocket Activity.

The Sparklet Rocket and Newton’s Third Law

by Geoffrey Millar
Reprinted from SASTA Journal 85(2)

Section Editor’s Note: The attention of teachers is drawn to the safety precautions necessary when conducting this experiment.

One method available to the physics teacher to demonstrate the ideas described in Newton’s Third Law is with rocketry. The simplest rocket available is found as the common soda sparklet selling for a few cents in supermarkets. The sparklet contains carbon dioxide under high pressure for use in domestic soda siphons. For the sparklet to metamorphose into a rocket, a number of steps need to be taken.

The way to best show off the sparklet rocket is to run it along a tight guide wire. Thick fishing line can be used with excellent results. The sparklet will be suspended under the fishing line using a plastic drinking straw. Adhesive tape is used to connect the
sparklet to the straw. The problem is now to release the compressed carbon
dioxide from the sparklet.

A metal plug is used to seal the gas in
the sparklet. Under normal conditions,
this is pierced as the sparklet is
screwed into the siphon. Piercing the
sparklet has been the biggest problem
that I've had with the demonstration.
With the help of my lab assistant, a
solution was found to the problem of
reliable firing. Make a small nick in
the metal plug before mounting the
sparklet. To the plug end of the
sparklet, place a small sleeve of plastic
tubing about 1 cm long. Fill this with
plasticine, and insert a drawing pin
with its point sitting in the nick. The
'rocket' is now prepared for launch!

To launch, the sparklet needs to be
thrown along the guide wire backwards
so that it hits a support. If the blow is
sharp enough, the drawing pin will
puncture the sparklet. The carbon
dioxide will escape rapidly, propelling
the sparklet down the wire at high
speed.

The whole demonstration is best done
outside. The fishing line should be as
tight as possible without any knots.
The line should be as long as possible
(eg 30 or 40 metres).

As the sparklet becomes a fast moving
missile while travelling along the
wire, make sure there are no people in
front of it. In fact, all should be
behind the firing support!

There are many calculations that can be
made from measurements of the time
the rocket takes to cover a measured
distance. Here are some typical results.

**Acceleration**

This assumes a constant acceleration
over a measured distance. Measure
about 20 to 30 metres. Have students
with digital (easier to read) stopwatches
find the time of travel.

\[ s = ut + \frac{1}{2} at^2 \]

By substituting the following typical
values in the formula above (\( s = 25 \)
metres, \( t = 0.7 \) second, \( u = 0 \) m/s), it
can be shown that:

\[ a = 100 \text{ m/s}^2 \]
Extensions to the Bottle Rocket Activity

by Ronald J Bonnstetter

The March Issue of *Science Education International* contained a wonderful introduction to the world of rockets using simply a plastic bottle. I could not help but see a multitude of possibilities as I read that activity. I would like to suggest that each of us not only continue to share our ideas and activities, but invite others to take these ideas and share how they have altered or created extensions.

I have experimented with the concept of using plastic bottles as rockets for several years. The primary difference between the March Issue description and my most recent work involves controlling the pressure being added to the bottle. In other words, rather than simply corkscrewing the bottle and letting it launch at will, I hold the plastic bottle in place until I have the desired pressure. The design for this launch pad was published in the October 1991 National Science Teachers Association Scope Journal.

With control over launch pressure, and the ability to employ a count-down for launch, the possibilities for experimentation are almost endless. Let me offer just a few suggestions to get you and your students started. Once introduced to this learning tool, they will have many more wonderful ideas.

How do different sized bottles compare?

How will angling the launch pad affect the trajectory?

How would the rocket respond if mounted on a skateboard?

How might you decorate your rocket (lower elementary)?

How might you attach a parachute?

Design ways of transporting a payload (an egg?).

How could you safely illuminate the rocket for safe night flight?

How would altering the nozzle diameter affect altitude or velocity?

How could the rocket be modified to accommodate a horizontal trajectory?

What is the rocket's inertia at different points along its flight path?

How does varying the launch pressure or volume of water in the bottle affect velocity and/or altitude?

What are different ways of calculating maximum altitude?

What is the maximum time aloft?

How does the plastic rocket circumference vary with pressure?

How would streamers affect the launch?

What is its acceleration?

What is its maximum velocity?

What is the best way to attach fins?

How do you attach fins to make the rocket rotate?

How does rotation affect altitude and trajectory?

How does pressure, amount of water, use of nose cone, and fin arrangement affect acceleration, velocity and altitude?

How do 16 oz bottles compare to 2 liter bottles?

Calculate fuel and pressure needed to hit targets?

How could you make it produce noise during the launch?

How does altering the centre of mass affect performance?

Other ideas I would like to pursue include (1) how to interface photo gates to a computer to collect data on acceleration, or (2) how to cement a stack or series of 2 liter bottles together to form a super rocket.

I hope you have as much fun with this as we have had.

About the Author

Ronald J Bonnstetter can be contacted at 211 Henzlik Hall, University of Nebraska, Lincoln, NE 68588-0355.

Acknowledgement

NEW ICASE PUBLICATION
Who's Who in Science Education
Around the World
1991 Edition

INTERNATIONAL COUNCIL OF ASSOCIATIONS
FOR SCIENCE EDUCATION

Who's Who in Science Education
Around the World

Published by ICASE
With assistance from UNESCO

This new ICASE publication, published with the assistance of UNESCO, contains brief profiles on prominent science educators, their work, their projects and their interests. The valuable reference book includes key women and men in many countries throughout the world who are contributing to science education at primary, secondary or tertiary levels.

The information will help readers to contact colleagues in both developing and developed countries who may be working on projects of interest to them, who may be potential speakers at upcoming meetings or conventions, and who may be invited to work on collaborative projects.

Copies at a cost of US$15.00 or £9.00 or A$20.00 including postage can be ordered from the Editor:

Brenton Honeyman, Editor
10 Hawken Street, Monash, ACT 2904, Australia

or

Dr Jack Holbrook, Executive Secretary, ICASE
Dept of Curriculum Studies, University of Hong Kong
Hong Kong

Dennis Chisman, Honorary Treasurer, ICASE
Knapp Hill, South Harting, Petersfield GU31 5LR, UK

Cheques payable to "ICASE"
NOW AVAILABLE

1992 ICASE Yearbook
The Status of Science Technology Society Reform Efforts Around the World

Edited by Robert E Yager

FOREWORD

Science Technology Society attracts even more attention than it did en years ago when it became a new focus for reform in a few nations like the United Kingdom, The Netherlands, and, to a lesser extent, the United States. Currently it is a focus in nations on every continent. For many it represents the most significant change seen in classrooms during this century. For some the reform seems slow – not to be realised to any degree before the year 2000.

This Yearbook has been prepared as a means of updating science educators and ICASE member societies around the world. Hopefully it will help coalesce the concept in all nations and provide support for emerging projects in other nations. The reports are offered in the spirit of providing a status statement. Also, information is included that can be used as evidence for STS as real reform. Hopefully such evidence will be useful for schools and the most innovative and creative teachers in science societies who are struggling with STS in their own situations. The Yearbook is organised as:

- STS definitions and rationales
- Examples of STS initiatives
- Evaluation of STS efforts
- STS moves in various nations

The authors all hope their contributions provide useful information and suggestions. They all hope that the Yearbook provides a needed record of where we are while also being controversial enough to promote debate and dialogue.

Electronics Teachers' Guide

No 40 in the Document Series on Science and Technology Education

Published by Unesco

This document, the second to appear on the teaching of electronics in the Science and Technology Education Document Series, has been prepared as part of Unesco's science and technology education program.

Electronics Teachers' Guide has been specially written by John Lewis for Unesco. Whereas most educators agree on the importance of including electronics within the school curriculum, there are conflicting views on how this should be done. The program of work was developed according to the following guidelines:

- The work forms part of a lower school physics curriculum. That represents the end of formal contact with physics for many students, hence the content has been devised to systematically progress towards this end point.

- The work is concerned primarily with the conceptual building bricks of electronics, using an appropriate level of complexity. The idea is to give a taste of how more complex units are built up from simpler building bricks, without making things too complicated.

- The work assumes that about 9 weeks (or 27 periods) will be available for the study of electronics within a Physics course.

- The work emphasises the ways in which electronics is used to perform useful tasks. This electronics course shows how electronic systems interact with the real world to control external devices.

For further information, write to:
Science and Technology Education Section
Education Development Division
Unesco
7 Place de Fontenoy
75700 Paris
France

What Research Says to the Science Teacher about STS

This volume, edited by Robert E Yager and published by the National Science Teachers Association, focuses upon research concerning STS with an emphasis on results of efforts in the US. It provides much additional information concerning emerging assessment and evaluation data of value and interest to the international STS movement. The publication is available by contacting:

Special Publications, National Science Teachers Association
3140 North Washington Boulevard
Arlington, Virginia 22201, USA
ICASE is keen to arrange regional or world events for the benefit of member associations. If your association or organisation is interested in hosting an international seminar, workshop or conference, contact the Executive Secretary or your Regional Representative. To gain ICASE endorsement, the meeting must be international in nature, open to member associations, and, while all sectors of the science education community should be encouraged to participate, must be relevant to classroom teachers.

1992

**June 10-12**
**ICASE Research Seminar on Chemistry and Physics Education**
Location: University of Dortmund, Germany
Contact: Prof Dr Hans-Jürgen Schmidt, University of Dortmund, Department of Chemistry, Otto-Hahn-Straße, 4600 Dortmund 50, Germany
This symposium on empirical research in chemistry and physics education will focus on the methodology of empirical research in this field. There will be approximately 12 presentations each followed by a discussion period. The language of the symposium will be English. A Proceedings will be published through ICASE.

**July 6-10**
**CONASTA 41**
Location: University of Western Australia, Perth, Western Australia
Contact: Nic Soufolis, Convener CONASTA 41, Science Teachers Association of WA, PO Box 222, Claremont, WA 6010 Australia (Fax +61-9-385-1509)
The Australian Science Teachers Association invites you to participate in the forty first annual conference of the Association. The theme of Science and our Economic Future will be addressed from the viewpoints of government, scientific research, applied science and technology, the environment, industry and commerce, and education. Outstanding national and international educators, scientists and classroom practitioners will present keynote addresses and workshops, and a variety of excursions will be offered. A comprehensive display of resources useful to science teachers will be presented by publishers, booksellers, equipment and computing companies.

**July 22 - August 5**
**34th London International Youth Science Forum**
Location: London, UK
Contact: LIYSF, PO Box 159, London SW10 9QX, UK, Fax 071-835-1070
The Science Forum is the principal annual meeting in Britain of young scientists. Over three hundred students attend from some fifty nations to make this an international event of major significance. The program features lectures, seminars and demonstrations from leading scientific names, and an extensive range of visits to university and industrial research establishments in London, Oxford, Cambridge and other centres in southern England. Accommodation in London University Halls of Residence together with all meals and a supporting social program are included in the participation fee of £650.

**August 2-10**
**Eighth ICASE Asian Symposium**
Location: Colombo, Sri Lanka
Contact: Mr Asoka Weerasinghe
Hon. Joint Secretary, SLASME, Institute of Computer Technology, PO Box 1490, Colombo, Sri Lanka
Science educators are invited to attend the eighth ICASE Asian Symposium and enjoy the natural beauty of the country and the hospitality of the Sri Lankans. The Symposium, organised jointly by ICASE and the Sri Lanka Association for Science and Mathematics Education (SLASME), will feature outstanding speakers from many countries who will address the theme "Science Education for a Changing World". The Symposium aims to identify some of the changes affecting our daily lives and to discuss ways by which science education can respond to these changes. Subthemes include (1) technology, (2) appropriate technology, (3) environment, and (4) scientific literacy. Participants will be able to experience the world famous pageant "The Kandy Perahera" in Sri Lanka. 100-150 science and mathematics educators from all parts of the world, and 200-250 local delegates are expected to participate in this event.

**August 31 - September 3**
**SCICON Biennial Conference of NZSTA**
Location: University of Waikato, Hamilton, New Zealand
Contact: Neil Uting, Education Advisory Service, 4 Hill Street, Hamilton, New Zealand
The theme of SCICON for 1992 will be Science - Technology . . . A Partnership . Information and registration forms about the biennial national conference of the New Zealand Science Teachers Association can be obtained from the contact above.

**September 19-21**
**Second General Conference of Teachers**
Location: Poland
Contact: SNPIT, Strytuka Poczotowa 62, 85-791 Bydgoszcz 32, Poland
This second General Conference on the theme 'Education, Environmental Protection and Industry' is being organised by
the Association of Science and Technology Teachers (SNPPT), Poland. Languages used will be Polish and English.

December 17-21
Twelfth International Conference on Chemical Education
Location: Bangkok, Thailand
Contact: Dr Somjai Wichaidit, The Secretariat - 12th ICCE, c/o Research Centre, Faculty of Medicine, Ramathibodi Hospital, Rama 6 Road, Bangkok 10400, Thailand
The theme of the Twelfth International Conference on Chemical Education will be *Chemistry in Transition* and it is hoped that the participants will interpret this in many different ways. This biennial Conference, to be held for the first time in South East Asia, is organised by the Committee on Teaching of Chemistry of the International Union of Pure & Applied Chemistry, and The Chemical Society of Thailand in cooperation with UNESCO. It is attended by chemistry teachers at both high school and university levels who wish to improve their teaching and to learn from one another techniques and experiences. A second circular including instructions for submitting abstracts is now available from the address above.

1993

January
ASE Annual Meeting
Location: UK
Contact: Annual Meeting Secretary, ASE Headquarters, College Lane, Hatfield AL10 9AA, UK
Full details of this large international event will be circulated in *Education in Science*, a journal of the Association for Science Education.

January 3-8
International Conference on Science Education in Developing Countries
Location: The Amos De-Shalit Israeli Science Teaching Center, Israel
Contact: Conference Secretariat, ORTRA Ltd, 2 Kaufman St, PO Box 50432, 61500 Tel-Aviv, Israel (conference arrangements) or Dr Avi Hofstein, Department of Science Teaching, The Weizmann Institute of Science, Rehovot 76100, Israel (academic correspondence)
This international conference on the theme "Science Education in Developing Countries: From Theory to Practice" will review past experiences and achievements in science education and plan for the 21st century with a special focus on developing countries. The conference will feature plenary lectures, symposia, poster sessions, workshops, exhibitions, informal discussions, social events and local visits. Topics for symposia and plenary lectures will focus on current research on learning and teaching and its implications for (1) the learner, (2) the teacher, (3) the classroom, and (4) the curriculum.

April 21-25
International Conference on Geoscience Education and Training
Location: University of Southampton, UK
Contact: Mrs Esther Johnson, GEOED Conference Secretariat, Department of Geology, University of Southampton, Southampton S09 5NH, UK
The Association of Geoscientists for International Development (AGID) and the Commission on Geoscience Education and Training (COGEOED) of the International Union of Geological Sciences are convening this international conference with the support of ICASE. Themes include: geoscience education in schools; higher education; geoscience training for business, industry and public service; and public understanding of geoscience. The conference is open to all those with an interest in geoscience education and training - including practitioners and those involved in administration, course development, and the supply of resource materials.

June 27 - July 3
VII Pacific Science Inter-Congress
Location: Okinawa Convention Center, Okinawa, Japan
Contact: VII Pacific Science Inter-Congress, c/o Section of International Affairs, University of the Ryukyus, 1-Senbaru, Nishihara, Okinawa, 903-01, Japan
The Symposia will be organised around the theme *The Pacific: Crossroads for Culture and Nature* and subthemes (1) Cultural Interchange among Pacific Peoples; (2) Speciation, Dispersal and Conservation of Species in the Pacific; (3) Towards Appropriate Technologies and Policies for Development and for the Conservation of Natural Environments in the Pacific. Scientific sessions organised by the Scientific Committees of the Pacific Science Association focus on a range of science disciplines and issues, including Science Communication and Education.

July 6-11
Project 2000+ International Forum
Location: Paris, France
Contact: Dr Jack Holbrook, ICASE Executive Secretary, Department of Curriculum Studies, University of Hong Kong, Hong Kong
This worldwide conference, organised by ICASE in conjunction with Unesco and other international bodies is the second phase of the three phase Project 2000+ (refer to article in this issue for more details of this project). A number of international and regional conferences are generating input into this international forum. The theme of the forum addresses the issue of Scientific and Technological Literacy for All. Sessions will establish agendas for future action. Attendance will be by invitation only (500 participants). Names are now being sought from a wide variety of organisations with an interest in science and technology education (see next page). The forum plans to issue statements to affect political visibility for science and technology education for all as a requirement for national development, and provide a framework for major programs of action in science and technology education involving governments, IGOs and NGOs.
International Forum

Scientific and Technological Literacy for All

Phase 2 of Project 2000+

Paris, France
6-11 July 1993

This International Forum is the Second Phase of Project 2000+, an international project on scientific and technological literacy for all, which addresses the following 6 focus areas:

1. The nature of, and the need for scientific and technological literacy
2. Scientific and technological literacy for development
3. The teaching and learning environment for scientific and technological literacy
4. Teacher education and leadership for scientific and technological literacy
5. Assessment and evaluation for scientific and technological literacy
6. Non formal and informal development of scientific and technological literacy

Attendance will be by invitation only and limited to 500 participants. Names are now being sought from:

- National EFA (Education For All) Groups
- National policy makers overseeing science and technology education
- INISTE centres
- Project coordinators and field workers for organisations
- Science and technology teacher associations
- Institutions, centres, universities and colleges involved in science and technology curricula, examinations and teacher education
- Science and technology out-of-school centres and organisations
- Non formal science and technology educational organisations
- Industrialists
- Persons from the mass media interested in Project 2000+

Organisations, associations and institutes are invited to submit names of suitable participants to the Project 2000+ secretariat before the end of September 1992. A short description of each person should also be included covering:

(a) activities of the person nationally (within organisation if appropriate)
(b) international involvement (at conferences, research, projects, etc)
(c) which Project 2000+ focus area is of greatest interest

Individuals can also apply. Individuals will be selected based on paper abstract, submitted by the end of September 1992, related to one of the focus areas.

Selection will take place at the end of 1992 and will be finalised by approval of the Steering Committee at the end of January 1993.

There will be a US$100 Registration Fee for each participant to help defray material costs. This will be payable to the Project 2000+ Secretariat on receiving the invitation. For further information, contact: Dr Jack B Holbrook, ICASE Executive Secretary, Department of Curriculum Studies, University of Hong Kong, Hong Kong.
Extending and improving education in science
for all children and youth by assisting
member associations throughout the world

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Australia
Science Education International is the Quarterly Journal of the International Council of Associations for Science Education. ICASE was established in 1973 to extend and improve education in science for all children and youth by assisting member associations throughout the world.

This journal provides a means for associations, institutions, centres, foundations, companies and individuals concerned with science education, to share perspectives, concerns, ideas and information which will foster cooperative efforts to improve science education, and which will serve as a chronicle of the advancement of science education throughout the world.

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December 1 November

ICASE News

Feature Articles
The Other Side of the Classroom Coin
O J Jegede & P A Okebukola
Discrepant Events: An Alternative Teaching Process
Z Kavogi
Indigenising the Science Curriculum in Ghana
J M Yakubu

Science Education Around the World

Research for Teaching and Learning
Is Chemistry a Male Domain? J Beard, C Fogliani.
C Owens & A Wilson

Science Teacher Education

The Necessity of Variety in Teaching
R J Bonnstetter

Primary Science

Science Education in Primary Schools in Sri Lanka
L S Kuruppu

Resources

Calendar

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or to one of these subscription centres:

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1
Scientific and Technological Literacy for All

Phase 1 of Project 2000+

By Dr Jack Holbrook
ICASE Executive Secretary

Over the last few months many people have asked me the meaning of 'scientific and technological literacy'. My answer has tended to be, "If I had the answer, there would be no need for Project 2000+. In particular, there would be no need for the Phase 2 forum, one part of which will try to spell out the meaning(s) of scientific and technological literacy for all."

Others have suggested that the word 'literacy' is inappropriate in this context. My response has been, "Perhaps this is so, but what word is appropriate? Can literacy merely be applied to reading and writing, or does it overlap with common sense - and, if so, is not science and technology invading everyday life so much today, that it is virtually impossible to divorce it from common sense?"

Take a recent incident I experienced in Thailand. The driver taking me to a meeting stopped at a petrol station to fill up the vehicle with petrol. The driver, having a few moments of relaxation, lit up a cigarette and climbed out of the vehicle. Nothing happened (as I am here to relate the story) but how lucky was I? What risk was the driver taking? Is this part of literacy?

Project 2000+ (refer to earlier issues of Science Education International) is aiming to redirect science education away from its overwhelming reliance on the 'science for the scientist' approach for the compulsory years of schooling (and even well beyond). The project is encouraging the world community to view education in science and technology as critically important for 'general education'. It emphasises that the increasing developments in science and technology affecting our everyday lives put forward and many countries initiated task forces to put these resolutions into practice. But while science and technology were considered important, little was said during the conference about scientific and technological literacy. Project 2000+ follows up the Jomtien meeting and, through task forces during Phase 3 of the project, will move toward greater scientific and technological literacy.

The Phase 2 forum, planned for July 1993, is being held to consider in depth the meaning of scientific and technological literacy. The forum, however, will not stop there. Other groups in the forum will examine developmental needs, curricula needs, teacher and teacher education needs, assessment approaches needed and the role of non-formal and informal education programs towards attainment of scientific and technological literacy. Thus Project 2000+ is concerned not only with the meaning of this term, but also with how we go about achieving it and then, more importantly, developing and carefully evaluating national projects, research programs, development strategies, etc., that give direction to the achievement of a level of scientific and technological literacy for all that is commensurate with the needs of students and adults in the 21st century.

Phase 2 of Project 2000+ is thus being planned as 'how to' forum - how to teach; how to re-train teachers; how to assess; how to evaluate courses, textbooks and teaching materials; and how to link developments in school with developments in the community as a whole. The forum is not looking for the answer - but for good practices that can form the basis for the development of ideas elsewhere, and that can be linked with other developments across Project 2000+ focus areas to provide positive directions for countries around the world to undertake comprehensive scientific and technological literacy projects.

An important premise of the organisers of Project 2000+ is that much has been, or is now being developed,
written, discussed, and even taking place that can shed light on possible directions and approaches to be adopted. Such material is not necessarily universal, but may stem from national/sub-national projects and may encourage similar developments once educators share and appreciate such ideas alongside those generated in the Phase 2 forum.

It is to this end that attention is drawn to the important need for Phase 1 materials. Phase 1 is the collection of all materials that assist in better understanding of scientific and technological literacy, and the ways in which it can be achieved within school, outside school, through:

- new curricula
- the acquisition of resources
- different approaches or emphases on teacher or in-service education, including approaches to the way in which such education is developed and disseminated

- the modification to approaches, style, emphases and acceptance in the examining of students — a crucial concern in many countries around the world.

The single biggest factor inhibiting change in teaching towards greater literacy development around the world must surely be the manner in which students are assessed. The overwhelming reliance on summative, written examinations, overloaded with factual recall — often in the form of multiple choice items — must surely rank as a major target for reform in many countries. But how? Many countries have tried classroom assessment of various kinds that have involved teachers in increased administration, while others have adopted a non-aggregating, profiling system that the tertiary sector find difficult to understand and appreciate.

Phase 1 materials are thus vitally important. Your help is needed now to obtain these in the six focus areas of Project 2000+. While we have been steadily collecting research papers and journal articles on the need for and nature of scientific and technological literacy, also needed are materials related to assessment, evaluation, teacher education, classroom environments and development of strategies that bear on the manner in which students can be better equipped as the adults of tomorrow to cope in a scientific/technological world. The materials, in many instances, may not be solely related to science and technology. For example, teaching strategies involving role playing are not specific to science and technology.

Material is needed that is local as well as international. Internationally, these can be extracted from journals or conference proceedings. What about local developments, ongoing projects and procedures being developed or implemented in a region or country? How can we bring these ideas to the attention of the world community? Can you assist?

All types of materials are required, including booklets by science teacher associations on teaching ideas; videotapes on the development of new practices; slides that show the use of the environment, food, health, etc., in scientific and technological literacy development; project materials and assessment approaches. These can be sent to:

Prof John Penick, Science Education Center, University of Iowa, Iowa City, IA 52242, USA, (in particular, material related to the nature of scientific and technological literacy)

Emmanuel Apea, Chief, Science & Technology Education, Unesco Division for the Development of Education, 7 place de Fontenoy, 75700 Paris, France

Dr Jack Holbrook, ICASE Executive Secretary, Department of Curriculum Studies, University of Hong Kong, Hong Kong (soon moving to coordinate the Project Secretariat at Unesco Headquarters, Paris, France.)
New Member of ICASE
Earth Science Teachers Association

The latest member of the ICASE family is the Earth Science Teachers Association (ESTA) in the UK. This organisation was formerly the Association of Teachers of Geology. This association has about 900 members, most of whom are teachers in secondary schools, but includes members from all levels of education. The aim of the association is to encourage and support the teaching of earth science, whether as a single subject such as geology, or as part of science or geography. The ESTA issues a quarterly journal Teaching Earth Science and holds an annual conference in September. The 1992 Conference is being held in Cardiff, 18-20 September; the 1993 Conference will be held at the University of Leeds. There are also a number of working groups which provide information and support to teachers. These include primary education, curriculum development, syllabus and examinations, promotions, teacher training and fieldwork groups. The promotions group produces teaching materials such as colour slides and maps and other teaching aids.

The corresponding member for ICASE purposes is:

Dr Denis Bates
Editor, ESTA
Institute of Earth Studies
University College
Aberystwyth
Wales SY22 3DB
UK

Any members of ICASE interested in exchanging journals or receiving sample copies of Teaching Earth Science should contact:

Mr John Reynolds
Treasurer, ESTA
18 Gardiner Drive
Longton
Stoke-on-Trent, ST3 2RQ
UK

Longman International Education
New Company Member of ICASE

ICASE welcomes Longman International Education as a Company Member of ICASE.

Graham Taylor, Managing Director, has provided the following information about the activities of this major educational publishing company.

Longman International Education (LIE) publishes materials for the education systems in the developing world and for Africa, the Caribbean and the Arab World in particular. There are three main aspects to the work of LIE:

• new publishing;
• the provision of a publishing service; and
• the management of Longman's overseas companies.

Longman International Education's extensive backlist includes titles at all levels from pre-school to post-graduate level and in all subject areas. LIE continues to publish in the open market but now in addition often works in collaboration with Ministries of Education in the countries concerned to produce the materials they require for their school systems.

In the Arab World, the main emphasis is on the provision of English language teaching materials. Thus we supply courses for the entire school systems of Egypt, Sudan, Jordan and Oman.

In Africa, LIE publishes both in English and in indigenous languages, and in all subject areas.

LIE also publishes professional and vocational material for the developing world in general, as well as two fiction series Longman African Writers and Longman Caribbean Writers.

An increasingly important aspect of Longman International Education's work is to provide a publishing service for African and other publishing houses and Ministries of Education where such expertise is not yet available.

Lastly, LIE is involved in the management of the Longman subsidiary and associate companies in Africa and the Middle East.

For further information, contact:

Longman International Education
Longman House
Burnt Mill, Harlow
Essex CM20 2JE, UK

Project 2000+
Urgent Reminder

ICASE member organisations are reminded to collect and submit materials for Phase 1 as soon as possible. These materials will provide input to the Phase 2 Forum to be held in July 1993. Member associations are also reminded to nominate participants for the Phase 2 Forum.

Enquiries:

Dr Jack Holbrook, ICASE Executive Secretary
Dept of Curriculum Studies, University of Hong Kong, Hong Kong
1 The Nature of and the Need for Scientific and Technological Literacy

Scientific and technological literacy are basic to any education for the 21st century. Without such literacy, citizens will be poorly prepared for learning to cope with an increasingly technological environment and lifestyle and thus:

- the need for scientists, politicians and other key personnel to be scientifically and technologically literate as a basis for decision making to be able to participate meaningfully in science-related political issues;
- the need for people to be functional in an increasingly technological environment; 'operacy' in relation to machines; develop appropriate societal behaviour for the benefit of the individual, society and the environment as a whole;

2 Scientific and Technological Literacy for Development

Areas for consideration include national social, environmental and economic development with particular respect to:

- personal development including human and ethical values;
- quality of life issues such as sustainable development strategies, the environment, energy, population, and health;
- economic development, opportunities for employment at local, regional and national levels.

This particularly applies to:

(a) Life-long Science and Technology Literacy

As science and technology develop, now and in the future, efforts have to be made to prepare and sustain science and technology literacy throughout life. Efforts to promote public understanding of science and technology, for example through the media, in the local community, must complement formal education systems.

(b) Research into Scientific and Technological Literacy

Serious research efforts must begin to investigate needed basic concepts, the knowledge base, processes, and skills related to scientific and technological literacy. Further research must consider teacher education, learning environments, and career-related issues.

(c) Case Studies and Examples of Scientific and Technological Literacy in various settings

Descriptions of existing literacy programs and activities will stimulate discussion, research, and action. Such examples are essential for developing modes for educational development.

3 The Teaching and Learning Environment for Scientific and Technological Literacy

The ultimate goal of scientific and technological literacy is an individual who feels comfortable with and capable of learning and using science and technology. In developing this literacy, teaching must focus on the individual. Such focus requires a carefully planned and created learning environment. This learning environment includes:

- the role of the learner
- the role of the teacher
- the curriculum, and
- the physical environment where the learning is to take place

The desired role of the learner must be compatible with the nature of science and scientific literacy and what is known about how people learn. To be useful, this role must be carefully described and documented quite specifically.

Once the role of the learner is specified, a careful search of the literature should reveal appropriate teacher behaviour and actions which should lead to learners performing as desired. At the same time, a number of teacher roles and behaviours not desired will be identified. Combining these with a thorough analysis should lead to appropriate teaching strategies for enhancing scientific and technological literacy.

Since learners interact with the teacher in a context and physical locale, these too, must be designed for compatibility with the ultimate goal, scientific and technological literacy.

4 Teacher and Leadership Education for Scientific and Technological Literacy

The teacher and/or leader is a key figure in the learning environment. Hence, the teacher's and leader's own education must be carefully planned to optimise the learning environment. Teachers (and others directing an environment for developing scientific and technological literacy) must consider and control the learning environment and their own behaviours. If this is to occur, the personal education of teachers, leaders and directors must be equally well-considered and implemented. Such consideration will probably include:

- necessary background knowledge
- knowledge about teaching and learning
- appropriate attitude and commitment
- competence with appropriate teaching strategies
- ability to select, modify, and design curriculum
To achieve these, programs for educating leaders and educators must have specific components which lead to the capabilities desired.

5 Assessment and Evaluation for Scientific and Technological Literacy

Whereas assessment is most commonly used in formal school classrooms there is a need to use evaluation as a tool for accountability in all scientific and technological literacy programs. Educators need to assess regularly and meaningfully the academic achievement of their pupils. But, equally important, teachers must devise methods for monitoring their own teaching programs and the system in which they carry out their profession.

There are many issues to focus on, but attention should be drawn to:

- the need for valid assessment and evaluation for all desired goals (attitudes, creativity, the nature of science, application of knowledge), not just knowledge of concepts, vocabulary, and processes;
- the role of assessment and evaluation;
- public acceptability of appropriate assessment and evaluation;
- how such assessments/evaluations can be identified and monitored in formal and non-formal situations;
- use of formative as well as summative evaluation strategies;
- self-evaluation for users of technology;
- mechanisms for collecting relevant data;
- the role of evaluation agencies.

Assessment and evaluation should provide usable information for improving the quality of life and measuring the needs of a flexible workforce which can be more effective if scientifically and technologically literate.

6 Non-formal Development of Scientific and Technological Literacy

While formal schooling provides a major mechanism for enhancement of scientific and technological literacy, non-formal (museums; science centres; zoos; science clubs, fairs and camps) and informal (the media, science magazines, events, art, music) also provide significant avenues for development. In fact, for adults and out-of-school youth, these may play the major role. Knowing these, serious proposals must consider:

- identifying, supporting and publicising non-formal and informal mechanisms;
- the education of personnel for non-formal and informal efforts;
- linking schools with non-formal and informal institutions, events and mechanisms;
- evaluating the effectiveness of various non-formal and informal approaches.

There is a wide range of institutions and organisations involved in informal and non-formal education. These include national academies of science, associations for the advancement of science, and science teachers' professional associations as well as literacy adult education and distance education programs.

With these aspects considered, the role of non-formal and informal education is anticipated to improve and complement that found in the more formal school setting.

Simultaneously, adult scientific and technological literacy would be enhanced. And, since both non-formal and informal mechanisms involve mixed age groups, learning will be better viewed as a family and life-long affair. For further information contact:

Dr Jack B Holbrook, ICASE Executive Secretary
Department of Curriculum Studies, University of Hong Kong, Hong Kong

Wanted!

Science Activities Around the World

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6
The Other Side of the Classroom Climate Coin

by Olughbemiro J Jegede & Peter Akinsola Okebukola

The enormity of the task of implementing a science curriculum program often rests on the shoulders of the science teacher. Reduced to the classroom level, teachers attempt, on individual basis of student-teacher relationship, to communicate the ideas of science to learners in a way that the learning outcomes would be maximised.

In spite of all the very good tips about how best to teach science and especially in the age of inquiry and hands-on teaching, how many teachers still go home after a hard day's teaching, feeling everything but happy, confident and content that our students have really learned science?

If you think you are probably the only one that feels that way, a talk to the next science teacher and you would be surprised what little intrinsic reward we usually get from the strenuous and highly stressful effort and commitment we give to teaching science. For the teacher within a non-western and traditional society where the commonplace knowledge students acquire in the traditional setting is diametrically opposed to what school science teaches, this mismatch often creates a rift between the two worlds of science and culture with the learner being torn between the two.

To date, several studies have been carried out on classroom climate (Fraser, 1989). Within the psycho-social niche of the classroom environment, it has been found that factors like teacher support, teacher control and innovation, goal direction, cohesiveness, task orientation, to mention but a few, bear strong relationship to cognitive and affective outcomes of science education. While efforts have been directed at unravelling other variables that affect science teaching and learning, it does not seem that any concerted effort is being directed to study the socio-cultural niche of our science classrooms. Studies in this area are needed for two main reasons. The first is global in nature: culture, as the totality of all humans, does subsume every endeavour (and this includes science education) which we undertake. Science education is a cultural and human enterprise involving the transmission of cultural heritage of a people (Maddock, 1981; Gallagher and Dawson, 1984). Every investigation of human organisation ought to, therefore, tackle the socio-cultural framework. The second reason stems from our personal experiences as teachers of students in a non-western environment as well as of those in a western environment with a traditional background. Why is it that students in the categories mentioned above show certain traits which do not seem congruent with what is expected of

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Contact Dr Jack Holbrook, Executive Secretary ICASE
Department of Curriculum Studies, University of Hong Kong, Hong Kong
'normal' learners in science classes? For example, they hardly want, or display the urge, to ask questions in class; when forced to voice their opinions, some indicate that science has very little relationship with their daily life. Others think that the study of science is a weird, special activity requiring some magical and superhuman explanations.

To the science teacher who perhaps share the same socio-cultural background with this group of students, the issue is real but, nonetheless, frustrating. It is even worse and may be horrendous for the teacher with a western background who has to teach students of a non-western background. A typical case may be that of a permanent or Peace Corps science teacher of Western origin who finds himself or herself in a science classroom in Africa, Asia, South Pacific or the Caribbean. Such a teacher will find that these countries have a predominantly traditional environment characterised by ethos, values and beliefs quite different from what she/he is used to.

Based on our personal experiences as science teachers and teacher educators who have had to grapple with the effect of socio-cultural factors in the teaching and learning of science, we carried out studies to illuminate the socio-cultural aspects of the science classroom where an acute dearth of information has been noticed. The aims of the studies, carried out in Nigeria - the biggest and most populous African nation with a predominantly traditional society were:

- to develop an instrument, valid and reliable, for use in the study of socio-cultural factors in an African environment, and
- to investigate the socio-cultural predictors of outcomes of learning in science.

It was our belief that results from studies such as ours would not only add to the bank of knowledge on classroom climate, and particularly in non-western societies but provide useful information for teachers with a western background who find themselves operating in non-western classrooms. Similarly, teachers with culturally heterogeneous classes in a western environment with a good proportion of students from or within non-western background would also need more information for effective planning of science instruction.

In sum, the results of our investigations have led us to conclude that the following five predictors of socio-cultural influences in the learning and teaching of science in Nigeria are important for science teachers to be aware of.

**Authoritarianism**

This factor characterises the traditional society where the belief is strongly held that the older person, having been exposed to more life experiences, should be in a better position to appraise a situation and pass 'correct' judgement. The society frowns at a situation where the elder's point of view is challenged or questioned. On the basis of this, the elder asserts authority in decision making. It behoves the younger individual to accept without questioning, the directives passed down by the elder. This locus of authority of knowledge gets transferred into the classroom where the science teacher is seen as the elder who 'knows all' in matters relating to scientific facts, processes, principles and laws.

**Goal Structure**

This refers to the interaction pattern among the people of Africa which is predominantly of the co-operative kind. In the co-operative setting, the goal structure of individuals is directed at the same objective and there exists a high interdependence among the goal attainment of individuals. This contrasts very markedly with the individualistic competitive orientation school science portraits to learners.

**Traditional Worldview**

This relates to traditional beliefs and superstitions being used as the framework through which occurrences are interpreted. The society holds the notion that supernatural forces do have significant roles to play in daily occurrences. The younger members of the traditional society are supposed to grow up to learn and believe these without questioning. However, this creates conflict when that which is taught in the science classroom is not in agreement with the traditional worldview.

**Societal Expectation**

The success or otherwise of an individual within a community is developed and interpreted through the nature of interaction within a communal society. The behaviour of members in the community is invariable and intimately linked to, and governed by, that of the larger community. Hence, an individual, particularly a school child always reviews his/her achievement in school as a reflection on his/her home, friends and community.

**Sacredness of Science**

This pertains to conceptual interpretations of science. This is a pervasive view held by a large proportion of the African society in which the study of science is regarded as something special, requiring magical or weird explanation and incompatible with the thoughts of someone from a non-western society.

There is reason to believe that the currency of some of these factors may transcend international and regional boundaries particularly of Africa, Asia and the Americas (Gallagher and Dawson, 1984; George and Glasgow, 1988). This information might, therefore, prove very handy for teachers who are concerned about the comprehensive effectiveness of science teaching and are interested enough to know about the other side of the classroom environment coin.

Understanding the socio-cultural framework of a learner's mind is compatible with the emerging paradigm of alternative conceptions and constructivism in science teaching (Driver and Oldham, 1986). This will go a long way in helping to realise the five domains of science education as catalogued by McCormack and Yager (1989).
References


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Discrepant Events
An Alternative Teaching Process
by
Dr Zoe Kavogli

Can you make successful teaching of primary science a little more possible?

Introduction
Discrepant events are events which are unexpected or surprising to the viewer.

Primary science has changed greatly during the past 10 years in Greece. At one time, most science teaching was focused on the content of science. Nowadays, national programs in science education shifts the emphasis away from content towards processes. What are processes? They are how a scientist works, thinks and investigates. In other words, it is a method of investigating.

As in most countries of the world, so in Greece, the typical primary teacher is responsible for many different subjects. Science is not the only concern and it is often the teacher's greatest weakness. As a result, success in primary science is not easy to achieve. Within the teaching process we try to make successful teaching a little more possible. We take away the complexity so often built into science teaching. We do not worry about how to teach the process approach. Discrepant events provide teachers with many simple, concrete and easy-to-use examples of events or situations that encourage good teaching practices.

'Discrepant events' was an experimental project taught to the postgraduate teachers and applied in various primary schools in Greece. The characteristics of matter, heat, energy, static electricity, magnetism, current electricity, sound, light, lenses and colour, air and air pressure, weather and climate, and flight through the air were studied and applied. This project was beneficial for both teachers and students. Especially teachers drew a lot of conclusions on an alternative way of teaching which provided more active learning in primary classrooms. This process approach included many specific skills such as careful observation, recording of data, predicting, graphing, estimating, formulating hypotheses, classifying information, comparing, measuring, inferring, generalising, and controlling variables. All of these are methods of investigating which are the core target of Primary Science in the Greek National Curriculum.

What is a discrepant event?
Everyone has seen water run downhill. The fact is hardly surprising or unusual. However if you were to see water run uphill, it would be entirely different matter! Water flowing against the force of gravity would be a discrepancy. Most people know that ice melts at 32 degrees F. However, if you were to see a beaker of ice melting at 10 degrees F, what would you think? Again there would be feelings of curiosity and surprise. This would be especially true when, upon closer inspection, frost is seen forming on the outside of the beaker while ice is melting on the inside.

Water is expected to run downhill, not uphill; ice is expected to melt at 32 degrees F, not 10 degrees F. These examples of discrepant events are often described as paradoxical, unexpected, and surprising. A discrepant event tends to produce a rather strong feeling in the observer. Generally, he/she will have an inner feeling of wanting to know and is curious, wishing to resolve the discrepancy in his/her mind. Adults and children will display a desire to resolve the unexpected. Certainly the enthusiasm of the latter will be even greater. Children will simply not rest until they find out why certain events occurred as they did.

It is obvious that when students are strongly motivated conditions are favourable for learning. Therefore, any method that helps generate this motivation is worthy of investigation. Thus discrepant events capitalize on the student's curiosity, helping him/her gain a better understanding of science.

Although there is considerable value in the use of discrepant events, it is obvious that these can not be developed for every topic or scientific principle. In the absence of an appropriate discrepant event, it is entirely acceptable to present non-discrepant events in which the students have a chance to observe or perform some kind of investigation. The main point to remember is that the event is used as an incentive to student involvement. Discrepant events are presented whenever possible, supplemented with non-discrepant events wherever needed.

How to use discrepant events in promoting the processes of Science
Discrepant events are quite useful when care is taken to initiate a lesson properly and time is allowed for student investigation. The teaching of lessons can become effective when the following three general steps are employed:

Set up the discrepant events
In this step the event or events are presented to gain attention, increase motivation, and encourage pupils to seek ways of solving the discrepancy. The stage for learning is set since pupils are confronted with questions or problems that they want to resolve.

Involve the children in solving the discrepancy
After the event has been properly introduced, the pupils will
be anxious to seek an answer. Pupils will often engage in purposeful activity in attempting to solve the problem or resolve the discrepancy. This is the ‘messing about in science’ phase of the lesson. Students will be active in observing, classifying, predicting, experimenting and doing whatever tasks are relevant to the investigation. In addition, it is likely that they will learn the bulk of the real content in the lesson.

Resolve the questions

Under an ideal setting pupils will gradually resolve the questions by their involvement in step two. By their activities and experiences they will find the answers to many of the questions posed by the discrepant event. Moreover, they will have learned something about how to observe, classify, and experiment, as well as other related science processes.

Even if pupils are not successful in finding all answers, they will be ready to benefit from a more traditional treatment of the topic. Their questions and comments can gradually be brought into line with the basic scientific principles that apply to a particular event. Even if the teacher merely explains the answer, the explanation will be of far greater value than a traditional explanation, because at this point children have made some personal commitment to the problem and have a vested interest in the outcome. This is far better than merely listening to an explanation of some abstract principle read in a book.

To make the three steps more meaningful, they will be used in the following examples:

**Example 1**

*Set up the discrepant event*

Place a coin under a clear glass tumbler and tell the children to watch the coin closely. It is easily visible when seen through the side of the glass. Now pour water into the tumbler and presto the coin disappears! Repeat several times to be sure that all can see.

An event such as this is of great value in motivating the child. Even adults who see this activity are generally quite surprised when the coin disappears and will want to know how it works. From this point on, the push or ‘wanting to know’ comes from the pupils.

*Involve the children in solving the discrepancy*

Students’ activities will include questioning, experimenting, reading, predicting, recording data, and theorising. Students will be sorting out the relevant from the irrelevant principles related to the event and are likely to cover a wide spectrum of the basic principles of science.

Resolve the questions

Students will gradually resolve their questions by their activity in step two. These questions are then placed in the proper context of the science principles which apply to the events. The disappearing coin is part of a lesson on the refraction of light which occurs when light moves at an angle from one medium to another. When viewed through the side of the glass, the light travels through several different mediums (glass, water and glass again) and is bent so much that the light from the coin does not escape through the side of the glass. When viewed from the top, however, it is still visible, because there are only two mediums to bend the light and the light is not travelling from one medium to another at much of an angle.

In this sample lesson, we used only a single event to keep things simple. In a typical classroom setting, we would probably present several related events, all pertaining to the same basic principles to fit into a continuous discourse.

Let’s trace the method through a second example.

**Example 2**

*Set up the discrepant event*

Set up three bottles as shown in Fig 1. Blow across the top of bottle A and note its sound. Ask students to predict whether it will have a higher or lower sound. Then blow
across the bottle B and observe that it has a higher sound. Now ask students to predict the sound of C. This time they easily predict that it will have a still higher sound; confirm their prediction by blowing across C.

![Image of three bottles](image)

*Figure 1 A paradox of high and low sounds can be produced by striking the suspended bottles and blowing across the mouth of each.*

Ask students to generalise. They will probably say that the higher the water in the bottle, the higher the pitch.

Produce the sounds several times so that everyone is sure of his or her observation. Then tell the pupils that we need to check just once more in a slightly different way to verify our observations. This time, instead of blowing, strike each bottle with a pencil. Surprisingly the tones will be just the opposite of what they were before! - The higher the water in the bottle, the lower the pitch.

**Involve the children in solving the discrepancy**

At first glance the discrepancy is baffling to children. They will want to reproduce the blowing and the striking tones to verify all their observations. Probably they will also test the bottles with varying amounts of water in them. Naturally, they will be sharing and comparing their theories and results.

**Resolve the discrepancy**

A single principle of sound explains both the first and second set of sounds from the bottles. A small mass (or quantity) of a substance will produce a higher pitch than a larger mass (or quantity). When air was blown across the bottles, the air was set into vibration, but not the glass or water. Therefore, the bottle with the least air had the higher pitch. When the bottles were struck, the mass of glass and the water set into vibration, not just the air. Our principle is applied again. The bottle with the least glass and water produced the highest pitch. In both cases the smaller mass produced the higher pitch and the larger mass produced the lower pitch.

As in the first sample lesson, this event should normally be supplemented with additional events all pertaining to pitch. The explanation would then receive a more thorough treatment and be better related to a continuous discourse.

Let us try a third example.

**Example 3**

**Set up the discrepant event**

Have available several tumblers and an aquarium or large jar of water. Give a set of two tumblers each to several committees of students and ask them to pour air from one tumbler to another.

**Involve the children in solving the discrepancy**

In this case, the event is not so much a discrepancy as it is a perplexing and interesting problem. At first, students will say it cannot be done. Tell them it can be done and see if they can discover how.

**Resolve the discrepancy**

The solution is very simple. Merely invert one tumbler and lower into the water leaving it filled with air. Lower the other tumbler under the water and invert it, filled with water. Then tilt the tumbler that is full of air so that the bubbles escape and rise into the tumbler that has no air. In this way, we can clearly see the air as it is transferred (or poured) from one tumbler to another (Fig 2).

![Image of air transfer](image)

*Figure 2 Pour air from one tumbler to another under water. This activity is related to one of the important properties of air. When this event is solved, the children will readily know that air is a real substance and occupies space.*

Again, as stated in the two previous examples, the lesson should generally be supplemented with several other related activities all pertaining to the same property of air.

One final comment is necessary. The three steps are important only insofar as they are useful in permitting teachers to acquire techniques that promote instruction of the process skills. The steps are really only generalised procedures for setting up the beginning, middle and end of a good lesson. They should not be regarded as restrictive in any way. Within the three steps, teachers should feel free to use a wide range of techniques in teaching any given lesson.

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**Books**


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International Space Year

ICASE and ISY
The ICASE contribution to ISY is through two international projects:

Resource Materials for Science Teachers
Dr David Moore, ISY Project Officer for ICASE, is coordinating the production of a set of resource materials for teachers, in collaboration with the ICSU Committee on Teaching of Science. For further information, contact:
Dr David Moore
ISY Project Officer, ICASE
ASE Headquarters, College Lane
Hatfield, Herts AL10 9AA, UK

ICASE World Activity Day
Thursday 14 October 92
Theme for 1992: Space

Teachers and students in schools around the world are invited to participate in special activities focusing on the theme of space.
Thursday 14 October 1992 is designated as ICASE World Activity Day. Member associations of ICASE are requested to encourage schools in their countries to share in this worldwide program on 14 October. The activities, which can be adapted to suit students at all primary and secondary levels, include: (1) Designing, constructing and testing rockets which operate on compressed air and water; (2) Calculating the Earth's diameter by measuring the length of the shadow cast by a stick; and (3) Writing a short essay (maximum 1000 words) on (a) space travel in the year 2092 or (b) life as a student in 2092 as a result of space technology.

See the March 1992 Issue for an outline of these activities. For further information, contact: Brenton Honeyman, ICASE Journal Editor, 10 Hawken Street, Monash ACT 2904, Australia.
Indigenising the Science Curriculum in Ghana through the Science in Ghanaian Society Project

by Dr Joseph M Yakubu

Introduction

Richard Ingle and Tony Turner in their paper, 'Science Curricula as Cultural Misfits' (1981) state rightly that western science curricula imported into the Third World countries are both cognitive and cultural misfits. The consequence of this is that the young people who have received western formal education are, by and large, unemployable and de-acclimatized. They become cultural misfits. Rather than calling for the dismantling of schools or deschooling of society as Ivan Illich (1971) would suggest, science educators believe that the curriculum ought to be revolutionised. The 'Blackboard Revolution' or curriculum revolution is a world-wide process which started in the late 1950s. These years could be regarded as the years of Renaissance of science education. This consisted of the writing of new syllabuses and books, and devising new methods of teaching. The National Science Foundation of the United States of America set up projects such as the Physical Sciences Study Committee (PSSC). In Britain, the Nuffield Foundation set up the Nuffield projects in Biology, Chemistry and Physics.

In West Africa, this consisted of indigenising the curriculum. What do we mean by the term 'curriculum'? What do we construe the term 'indigenising' to mean? There is no agreed meaning of the term 'curriculum' but in this paper I construe it to mean as John Dewey defines it:

'... a selection of the kind of present experiences that live fruitfully and creatively in subsequent experiences' (Dewey, 1963).

If articulated this way, this definition will include those of Ralph Tyler (1949), Kerr (Lawton, 1973), Hirst and Peters (1970) and so on. It seems to have been agreed by all educationists that the characteristics of a curriculum should include aims and objectives, learning experiences, knowledge and evaluation.

The Oxford English Dictionary defines 'indigenising' to mean 'making natural to'. This implies that when we speak about indigenising the curriculum, we mean making it natural to our culture. It does not mean adopting or adapting these foreign curricula that have been in our societies since colonial times, neither does it mean just substituting local names for foreign ones in the syllabuses. It rather means that, with our knowledge of curriculum principles, science and our culture, we should be able to design curricula whose aims and objectives, learning experiences, knowledge, teaching methods and evaluation have their bases in our culture. My purpose in this paper is to describe and explain an attempt that is being made in Ghana to indigenise the science curricula.

The Science in Ghanaian Society Project: Its origin, rationale and objectives

The attempt at indigenising the science curriculum in Ghana is done through the Science in Ghanaian Society Project. The idea of using indigenous technology in science teaching came to me at a time when I became aware of the misfit between the teaching of science with foreign textbooks and the reality of the pupils' environments - natural, cultural and social. I noticed that the pupils became interested when a local example was used to illustrate a concept. They were then able to understand most of the ideas which I had to copy into my notebooks and learn by rote. I then decided to study science up to the School Certificate Level because I considered myself a brave boy who could tackle such an abstract subject as science which seemed to have nothing to do with my environment. This was a gamble, and I think that most of the pupils we teach science these days also take it as a gamble.

After years of teaching and study, my experiences and philosophy of science teaching have culminated in a project, the SGSP. Discussions were held with teachers and colleagues at the University of Cape Coast. Proposals were then written to look for funding in 1982. Fortunately, by August 1983, UNESCO and the British Council gave assistance in both cash and kind for the project to be started and the SGSP was started in December 1983.

Objectives of the SGSP

The objectives of the project were identified as follows:

- To study local industries in order to identify the scientific concepts and processes embedded in them
- To produce books on local industries and other aspects of Ghanaian culture relevant to science teaching
- To develop industry-oriented or interdisciplinary methods of science teaching
- To investigate ways of improving the image of the world of work of Ghanaian youth, especially senior secondary, junior secondary, and technical school leavers

The project at the moment is not to produce a course but resource material for both the teacher and pupils. As resource materials, the project books could be used to enrich the existing syllabuses. Later on, it should be possible to design a course from these materials, if the need arises. Providing the teacher with information and skills are of paramount importance in this project. Research in science education has indicated that the most serious problem of science teaching has something to do with the teacher's confidence or capabilities. Any attempt to improve the teacher's confidence...
will go a long way to improve the learning and teaching of science in our schools. Providing the teacher with information, new techniques of teaching and learning, are the strategies of the SGSP to improve the confidence of the science teacher.

Methodology of the SGSP
The project started investigating the indigenous industries because they are ubiquitous in the community. The case study method was found to be the most appropriate strategy to use. A case study is defined as an in-depth study of an instance (Kenny et al., 1984). An in-depth study of each indigenous industry was to be made. Since industries are interdisciplinary organisations, the interdisciplinary teaching method is the main method advocated and propagated.

The first phase of the project was to make case studies of indigenous industries and to develop interdisciplinary teaching methods. Practising science teachers in secondary schools and training colleges, and both District and Regional Science Organisers from all the regions were invited to participate in the first workshop of the project. Also invited to the workshop were representatives from the Department of Rural Development, the National Council for Women and Development, Technology Consultancy Centre, Kumasi, the Ghana Education Service Curriculum Research and Development Division and the Ministry of Science, Technology and Industry. Also invited were resource persons including economists, historians, appropriate technologists, scientists, social workers and industrialists.

At the first workshop in February 1984, the participants were taught how to make the case studies. They had two months to carry out the fieldwork using a format explained at the workshop.

A Writing Workshop was organised in April 1984. At this workshop each participant wrote up his case study and presented it for discussion. The presentation proved to be very lively and educative. The resource person gave comments that related to their fields of specialisation. All the comments were taken into consideration in the writing up of the case study books. The interdisciplinary methods of science teaching were explained and discussed. After the Writing Workshop, I wrote all the books. This meant doing a lot of reading and researching. Eventually 27 booklets were produced. This ended the first phase of the SGSP project. A report of the first phase of this project was written and sent to the sponsors – UNESCO and The British Council – together with sets of the 27 booklets. All the participants were given sets of the booklets. Copies were also sent to significant people in Ghana and abroad who would be interested.

In August 1985, I attended the Bangalore International Conference on Science and Technology Education for Future Human Needs. The SGSP books were exhibited and explained to the Industry Group of the Conference.

A third Workshop was organised in September 1985 for teachers who opted to try the books in their classrooms. The teaching methods were discussed and demonstrated. The booklets were also discussed critically. A questionnaire was given to each teacher to complete as he tried the booklets.

The completed questionnaires were returned by the teachers in 1986. The comments were noted. Two main suggestions came out. Some of the booklets were similar and could be brought together. The second comment was that the interdisciplinary methods are time consuming. It could disrupt the school timetable. There is the need to reconcile the pressure to finish the syllabus and the need to teach science for enjoyment and for life. These comments are being considered. The booklets are being reorganised into ten books. A fourth Workshop was organised to enable teachers to write examples of the interdisciplinary approaches for their colleagues.

The Philosophy of the SGSP
The philosophy of the SGSP is based on ideas of Robin Horton (1982). He distinguishes the African theoretical system of thought which he terms ‘Primary Theory’, from the western scientific system of thought which he calls secondary theory. He explains that the Primary Theory does not differ very much from culture to culture although the level of development of the theory will because experience is a variable factor. The Primary Theory embraces the world of human beings and enduring solid objects. It establishes the relationships between human beings and objects, among human beings, and between human beings and spirits. It is couched in personalised interpretations. The Primary Theory is also characterised by in-built ‘blocks to falsifiability’ (Shorupski 1976) which makes it appear to have the ability to explain everything. In this sense, indigenous Ghanaian thought is non-tentative and is unaware of its limitations. For indigenous people, there is always an explanatory framework for every phenomenon or problem encountered.

The Secondary Theoretical system, on the other hand, is based on intangible entities and establishes relationships between ideas and ideas. Horton’s ideas are evolutionist and he seems to assert a belief in universal culture especially the cognitive aspect he labels ‘theory’. The lower level of theory is the Primary Theory which exists in all cultures, and the Secondary Theory which is a higher level and resides in scientific thought. By implication, through cross-cultural exchanges, it is possible for the Primary Theory to be developed into a Secondary Theory. The Primary Theory exists because it is found to be efficaciously time-tested and not necessarily because of its age. Consensus is the method of legitimacy of the Primary Theoretical System while competition among rival theories is the method of legitimacy of the Secondary Theoretical System.

From this analysis, it appears that cultures which are stuck or ‘frozen’ by environmental constraints at certain stages of their development, from ‘primitive’ to advanced levels, can be ‘thawed’ to progress at their own rates. It seems to me that integration is an appropriate method by which this thawing process can happen. The indigenous technologies or actions seem to be the best media in which the Primary Theoretical system resides.

The SGSP studies the indigenous technologies or actions to identify the Primary Theory in them. Having done this, it reveals how the Primary Theory can be transformed in to the Secondary Theoretical level. The history of science (Williams 1976) tells us that the Roman craftsmen were
stagnant in their work because the Romans frowned on experimentation while the Arabs progressed in science because of their experimental techniques (e.g., Alchemy). The presence of the experimental technique removes the presence of blocks to falsifiability and therefore progress can be made. The SGPS therefore aims to infuse experimental techniques into the indigenous technologies.

Indigenous technologies are considered as issues-real problem areas in which not only ideas and techniques are at stake but also the economics, history, wealth production capacity, the environmental implications and social responsibility. For the interdisciplinary approach 'initiative, and originality in inventing and testing solutions together with thoughtful use of, and even extension of, one's resources of knowledge and skills, would be essential (Black, 1986). It is interesting to note that even though we are in a modern world of science and technology, the Ghanaiian population is still maintained by indigenous industries. For instance, the peasant farmer, using very simple techniques, still feeds us.

Appropriate interdisciplinary teaching methods termed industry-oriented methods have been developed for teaching the SGSP case studies. The industry-oriented methods include the following:

- Systems approach to science teaching
- Problem-Solving and decision-making
- Simulation Games
- Project Method
- Community Involvement Method
- Historical Method

**Systems approach to science teaching**

A system is understood here as an interconnected set of elements interacting and worthy of isolation for study. In this sense, a system has inputs and outputs or products. The inputs and the outputs can be seen but the interactions of the elements which lead to the product cannot be seen, producing a 'black box' situation. The factors which affect the interactions - variables - can be manipulated to produce a given form of product.

For instance, charcoal making (Book 1) can be used as an example. The charcoal pack is made up of layers of firewood, starting with larger logs at the bottom and ending up with smaller sticks at the top. The second layer is laid transverse to the first. The pack is then covered with fresh leaves of the plantain or cassava plant. This is then covered with sand to produce a mound. A gap is made at the bottom of the pack to allow air into it. The whole charcoal pack is regarded as a system and its inputs are the firewood and air. Fire is lit at the gap to set the firewood burning. The system is now a black box because we do not know how the wood is being turned into charcoal. However, we can identify the process that is going on inside it and then identify variables which we can manipulate to let the burning proceed the way we like. The variables are the passages of air into the system and out of it. Air enters through the main gap at the bottom and escapes through the top which is porous. The principle of hot air rises and cold air falls applies here. The cold air enters the bottom and the oxygen in it causes burning to take place. The hot air is lighter than cold air and therefore rises. A current of air into and out of the black box charcoal pack is set up.

If more air is allowed into the pack combustion becomes complete and ashes rather than carbon are produced. The controlled supply of air into the pack results in partial burning, distillation of the wood. In this process, the non-carbon components of wood are burnt off and escape as smoke leaving the carbon behind. Allowing very little air into the pack reduces combustion drastically. In such a case the charcoal will contain unburnt wood. Thus, by controlling the ventilation of the system, a certain quality of charcoal is produced.

In the systems approach the contents of test tubes, flasks, a whole process, a laboratory and so on are regarded as systems or black boxes. The factors which affect the interaction of the reactants in the system have to be identified and used as variables which can be manipulated to produce required products. The systems approach is actually the heart of the experimental technique.

**Problem-Solving and Decision-making**

'A problem exists when a threat or opportunity is recognised and one is not sure how best to act in order to counter the one or take advantage of the other.' (Suckling et al, 1978 p12)

In a developing country such as Ghana, there are threats of famine, desertification, and parasitic diseases. The problem is not that we are not aware of them but that we are not sure of where to find the solution. The SGSP tries to show how solutions to our problems are often found in our environment and indigenous technology. Identifying issues associated with them and basing our science teaching on them will go a long way to help us to transform them from a Primary Theoretical level to a Secondary Theoretical level. For instance, problems associated with energy resources (e.g., use of firewood and charcoal) can be tackled by posing a problem of a threat to our existence through desertification. Here, the SGSP Book 1 (Energy in Ghanaiian Society) will be the centre of the lesson.

Problem-solving is a systematic process comprising the following stages:

- Formulation of the problem to be clear and action-oriented.
- Interpretation of the problem laying out the scientific ideas and processes at stake and which need to be used.
- Generating courses of action; suggesting or conjecturing alternative solutions to the problem.
- Making a decision on which is the best solution considering its scientific, technological and social merits.
- Implementation of the selected solution keeping in mind the resources and constraints involved.

For instance, to understand desertification, the pupils must understand the concept of the ecosystem. Here again they are dealing with a system where interacting components are the producers, primary consumers, secondary consumers, decomposers, inorganic substances and energy. Again, this
becomes a black box. The problem is which factor is causing desertification? Most people depend on firewood and charcoal as fuel. How does this affect the ecosystem? Alternative solutions are suggested, including biogas production, transforming the indigenous stoves into more efficient ones and so on. Which of the alternative solutions is the best? Why is it regarded as the best solution? The implementation of a solution may include adult education, the production of the new type of stoves, or even new fuels.

This approach raises the level of consciousness of pupils who are the future policy makers, engineers and citizens. If they grasp the factors that underlie desertification now, we can have hope of arresting the fast rate at which desertification is proceeding. Similarly, pollution of soil, water and air, waste disposal problems in the cities, the short shelf-lives of vegetable oils, food preservation and so on can be problems which could be starting points for interdisciplinary science teaching.

**Simulation Game Approach**

A simulation is construed here to mean 'an operating representation of the central features of reality' (Ellington et al, 1979). A game is also construed here to mean a 'contest (play) among adversaries (players) operating under constraints (rules) for an objective (winning, victory) or pay off'. These definitions imply that the actual activities, out there in the society, are not played but that they are represented or acted in the classroom. The participants are actors in the game playing roles of certain people in real life situations. The SGSP Case Studies constitute a simulation of the real indigenous industries out there in the community. The pupils pretend to be the people working in these industries.

In the real world, competition is characteristic of industries as one industry tries to be the best in the world or country. Group work is very important in the simulation game approach, usually with each group representing a company. The best company will be the one that shows how it would use its technology, science, money, management and social responsibility will. The teacher also arranges to get someone from the real industry to judge and prizes are awarded.

In Ghana, pito brewing, a common activity, is one of the topics of the SGSP Book 4 (Fermentation in Ghanaian Society: Alcoholic processing and distillation). Groups of students represent Pito Brewing Companies, and groups try to show how they produce the best quality pito. Innovation such as preservation techniques, economic use of energy, and even marketing are considered. Continuing, gin could be another activity to be simulated. Gin can be distilled from the pito beverage, palm wine, fruits and molasses. Here again, priority is given to inventiveness and use of experimentation. Other case studies which can be simulated are industries (and issues!) related to fish smoking, gari production, vegetable oil extraction, farming, herbal medicine, or blacksmithing.

Games other than simulated case studies are used with shorter periods of time to play. For instance, Ludo, Snakes and Ladders, Monopoly, Oware, and cards can be adapted to teach certain concepts. For example, Snakes and Ladders can be used to teach about safety; Monopoly can be used to teach about how the productivity and growth of a company depends on the capability of its management.

Simulation games and games give the pupils the feel of being in certain situations even though they are not actually in those situations.

**Project Method**

A project is simply 'an extended piece of work on a fairly broad topic in which the pupil or group has a considerable degree of freedom in planning and carrying out investigations' (Hall, 1973). The project is actually another problem-solving and decision-making approach. The only difference is that the student or a group identifies their problem, generates his courses of action; makes his own decisions; observations, recordings, calculation, visits, interviews of people, hypotheses and tests.

Projects can be identified from any of the case studies on Energy (Book 1), Vegetable Oil Extraction (Book 2) Fermentation of Alcohol (Book 3) and Food Processing (Book 4). The experimental technique is central to the project work, providing opportunity for the pupil to learn how to experiment and think experimentally. This goes a long way toward infusing the experimental spirit which is lacking in the indigenous thought system into the pupil's explanatory framework. It also removes the barriers to falsifiability that exist in the primary theoretical explanatory framework.

**Community Involvement Approach**

An industry-oriented approach to science teaching is also community-oriented as the community and the school interact in such a way that each changes through the process. In developing countries the community is full of human resources or experts in various activities such as dyeing and weaving, brewing, herbal medicine making, soap and oil making, tanning, or blacksmithing. Since the teachers in the schools are not taught these activities during their pedagogical training they need to enlist the help of such cottage experts. The school will, in turn, help members of the community in other ways. Facilities such as buildings, library or football fields can be used by the community. The teachers can teach functional literacy including civic and health education to adults. Adult education thus changes from the learning of the alphabet to learning the meaning of existential situations of the community.

All the SGSP Case Studies lend themselves to the community involvement approach. Pito brewing, akpeteshie (gin) distillation, charcoal making, vegetable oil extraction, and food processing can be learnt by a community involvement approach. Health problems such as prevention of malaria, guinea worm and intestinal worm infestation, farming and so on lend themselves also to this approach.

Awareness is created in both the teachers and pupils, and also in the indigenous people of the community. Discussion and the appreciation of the views of others, a scientific attitude, is also created. Selection is a characteristic of science, but selection becomes impossible if plurality of ideas is not accepted. Open-mindedness may lead to the need to try-and-see or experiment and thereby remove the blocks to falsifiability that are inherent in the primary theoretical system of thought. Since the Ghana Government is advocating that all junior secondary schools should be
community schools, it is important that all teachers are made aware of what the community involvement approach is like.

Historical Approach to Science Teaching

Sherrat (1982) reports that in a presidential address, the President of the British Association for the Advancement of Science (BAAS) asserted that 'It is desirable ... to introduce into the teaching some account of the achievement of science and of the methods by which they have been attained ... There should be more of the spirit, and less of the valley of dry bones ... One way of doing this is by lessons on the history of science (BAAS, 1917 p 18-19)'.

Teaching 'the spirit of science' rather than 'the dry bones of scientific facts' is central to the philosophy of the SGSP. Although the case studies are not historical, they contain aspects of indigenous history which could be embraced in aspects of the history of science such as the development of concepts and methods. An attempt to draw parallels between indigenous thought and practice with science and technology may open our eyes to possibilities for improving indigenous thought and practices.

The historical approach can help the pupil to realize that scientific ideas are human constructions that form part of our culture. The primary theoretical explanations of the indigenous people are analysed in relation to a topic under discussion. For instance, in the indigenous explanations certain activities have their origins in hunters and fairies in the bush. A hunter encounters a fairy and is given the technology. These tales give the idea that the people do not know (and cannot explain) the origin of the technology and their 'blocks to falsifiability' will not allow them to say 'We do not know how such and such technology started'. Knowing the indigenous need for an explanation, the nature of scientific explanation can be discussed. Explanation through the agency of hunters and fairies suggests the diffusion of the technology from another society into the present one. Accidents can lead to discoveries, and there are examples of such in the indigenous experience.

The history of an indigenous technology can be discussed. For instance, I visited an Akpeteshie (Gin) Distillery near Cape Coast recently with my Masters students. One of the students asked whether they had tried fruits for distilling alcohol since they started production. They answered in the negative, and then he asked them why they did not do so. The answer was that it did not occur to them to try fruits and see what they would get since none of their predecessors thought of using a raw material different from the palm wine and sugar cane they had been using. From this discussion we realised that the Akpeteshie distillery is stagnant because of lack of experimentation. The historical approach can help us to identify what aspect of an industry can be transformed or what can be infused into the industry to bring about progress.

Visits to historical sites such as the ancient castles can be fascinating. For instance, the Portuguese came to the Gold Coast (Ghana) in 1482 and built a mighty castle as a trading fort which later became the main slave market. All the materials used in building the castle were imported from Portugal. The types of ships and navigational techniques of the day are discussed while building materials give an idea of the level of technology that existed in those days in Portugal. The factors which made it possible for the Portuguese to travel out to foreign levels are discussed and related to similar factors in Ghana.

The SGSP as a Strategy for Promoting National Development

Robin Clarke construes development to mean a 'process aimed at fulfilling mankind's highest aspirations' (Clarke, 1985 p 58). One may ask what Ghana's 'highest aspirations' are. This is stated very well in the Seven Year Development Plan (1964) which could be regarded as Dr Kwame Nkrumah's agenda for development. It was stated categorically that Convention People's Party (CPP) government aimed to 'establish in Ghana a strong and progressive society in which no one would have any anxiety about the basic needs of life, about work, food and shelter; poverty and illiteracy no longer exist and disease is brought under control; and where our educational facilities provide all the children of Ghana with the best possible opportunities for the development of their potentialities'. To strive to achieve these goals would rightly be explained as development.

There is a sense in which development can be understood to mean attempts to relieve people of their suffering by offering them aids of all kinds including food, health facilities and housing. Singer and others (1954) are of the opinion that progress is not motivated merely by the pressure of our needs but rather on the opportunities we have. This can be interpreted to mean that we cannot progress if we are merely desperate to relieve our present basic needs of food, health and shelter but we can progress only when we can identify what resources we have in our culture that we can try to improve with new techniques and knowledge. Such improved technologies will live with us forever if we are always improving them. Whether such improvements or transformation can be made or not, Clarke (1985) asserts that it depends on the knowledge available. He says that development is a measure of knowledge. The more scientific knowledge available, the more likely development can take place, the more likely the primary theoretical system can be transformed into the secondary theoretical system of science and technology. This implies that pupils should be helped to acquire scientific knowledge and techniques with which they can improve indigenous industries such as blacksmithing, vegetable oil extraction, food processing and preservation, dye stuff extraction, herbal medicine processing, salt making, fuel technology, or soap. These should be the objects of experimentation, hypothesising, and rational thinking of our pupils.

The SGSP Case Studies are portrayals of the opportunities that Singer and others are writing about. Our highest aspirations can best be realized through the opportunities we have, that is our indigenous technologies. The SGSP is therefore committed to educating pupils in science and technology for national development.
Conclusion

Clarke (1985) quotes Dr H B G Casimir, a past President of the Royal Netherlands Academy of Arts and Sciences as saying that science cannot be used for development. He was critical of the lip service by governments that science and technology are instruments of development. Ziman (1984) explains that science becomes an instrument when it acquires the status of a social institution ‘embedded in society and performing certain functions for society as a whole at par with other institutions associated with law, religion, political authority’. When so regarded, science and technology as an instrument or institution can be manipulated by politicians to satisfy their own ends rather than national aspiration. What Casimir is saying implies that national development ought to be synonymous with progress in science and technology. National development should be the same as science and technology development. This implies that to progress the government must give emphasis to science and technology education.

The question is what kind of scientific and technological development do we have in mind? The philosophy of the SGSP is that development of science and technology should be endogenous, that is, development that is internally motivated. This does not mean that external ideas should be excluded. What the SGSP advocates is the integration of the indigenous thought and practice with relevant imported science and technology. There should be a ‘grand titration’ of the two, as Joseph Needham (1969) explains. The SGSP is an example of a grand titration between indigenous Ghanaian thought and practice with foreign science and technology.

Acknowledgements

The SGSP has become a reality because of the encouragement of individuals and support organisations such as the following:

UNESCO, The British Council, the International Council of Scientific Unions – Committee for the Teaching of Science (ICSU-CTS), the International Council of Scientific Unions – Committee for the Teaching of Chemistry (ICSU-CTC) and IUPAC-CTC. I wish to render my sincere gratitude to all of them.

The present problem of the SGSP is with the publication of the eleven books of the project books. Support received so far has only helped to write the manuscript. The Ghana Universities Press needs money to print these books. Help is still sought to obtain money to publish the books.

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The International School
Education for Children of all Nations

by John Stiles

Our world is increasingly a global community. In the recent past there has been an awareness that ties between countries have become stronger and national boundaries have become less defined. The iron curtain was dismantled more quickly than anyone thought possible, developing countries are negotiating contracts with super powers, and satellite communication is able to probe even the most remote areas of the Earth.

Efficient and relatively cheap air transport makes it possible to travel half-way around the globe within a day. Imagine the incredible fact that there are people alive today who were born before the first successful airplane flight and, thus, have witnessed the entire history of man's propelled journey into air and space!

With this increased mobility and cooperative development has come an increase in the number of people who frequently travel or move to other parts of the world than where they grew up. And these people increasingly are taking their families with them. Most families do not stay long-term in their new location; generally they return home or, in many cases, move on to another foreign post within three years or so.

The first group of people to make such a move on a large scale were American businessmen, diplomats and military personnel shortly after World War II when the USA found itself in the position of becoming the world's leading economic and military power. As the population of Americans living abroad increased in all parts of the world, the desire for American schools grew so that children would be able to continue their education in a familiar setting and be able to return home without falling behind in the American curriculum. Even though there were perfectly adequate schools available in many overseas locations, language differences and academic requirements were expected to be great enough that it was not perceived as beneficial for children to enrol in local schools. However, many parents did enrol their children in host country schools, and continue to do so in order to reap the many benefits that come with the knowledge of another culture and fluency in a second language.

Regardless of the perceived wisdom of the scheme, American-type schools opened up wherever a sizeable American population became established. Americans were then assured of an easy transition for their children, and a continuity in education which made it easy for children to return to US schools. This was often a 'selling point' used by companies luring prospective employees to work in foreign lands.

As American economic interests grew, the number of American schools increased throughout the world. From the first school in Mexico over one hundred years ago, the number of these schools has increased to number in the hundreds. Today, virtually every major city of the world has, or has had (many schools in war-torn countries have closed) at least one of these institutions. In addition, other schools, such as British, Swiss and French were established in foreign lands, although in smaller numbers.

Nearly one-fifth of these 'expatriate' international schools are affiliated with the United States Department of State, and were originally opened in capital cities to educate children of US citizens living abroad. More than 270 additional schools are run by the US Department of Defense.

By the 1980's other countries, especially European and Asian, had grown economically to challenge and compete with American interests. As a result, large numbers of non-American students enrolled in the American schools, and many - if not most - of these students went on to colleges and universities in the US.

But not all wanted an American education for their children. New schools often opened which had a more international (generally European) structure to the curriculum. From those who lacked the numbers or the financial means to open new schools, requests for courses which reflected various cultures resulted in a re-designing of the American school curriculum.

Many schools underwent so many modifications that in many locales the name was changed from 'American School' to 'International School'. The basic curriculum remained American, but was modified to meet the needs of non-Americans. One of these changes was the introduction of the Geneva-based 'International Baccalaureate' program, designed to prepare students for entry into European universities. A great number of international schools have adopted the program which can be made a part of the existing school curriculum. Other international schools have been formed primarily for European students; these schools can incorporate Americans generally more easily than American schools can incorporate Europeans because American universities in most cases do not
require specific curricula, only certain standardized college entrance examinations.

The name 'International School' reflects the growing number of students from various countries who attend the same institution. It is not uncommon for more than fifty nationalities to be represented in one school. Generally, Americans make up the largest percentage of these student enrolments but, increasingly, other countries have made their presence felt. The percentage of non-American students has risen, reflecting the trend of non-American economic influence world-wide.

Approximately half of the more than 800 schools for expatriate children are private institutions which receive funding from tuition fees (Broman and Brown, 1991). Most fees are paid by the companies which employ the parents, but there are some parents who pay the fees directly. In addition, many of the schools are supported by the United Nations, while still others are affiliated with religious organizations. These schools are subject to the laws of the host country.

In Thailand, for example, the head of a school, by law, must be Thai. Therefore, schools have a Thai 'headmaster' who is responsible for legal and business concerns, and a 'superintendent', a non-Thai who is responsible for curricular and instructional aspects of the school. The headmaster hires Thai personnel, while the superintendent hires non-Thais, usually the teachers and administrators, most of whom are American or European. Additionally, Thai children cannot attend these schools except for unusual circumstances such as those of mixed parentage or students who have lived outside the country for a number of years.

In Britain, a similar situation exists. Non-teaching personnel in 'American' or 'International' schools must be host country nationals, and are often hired by a Business Manager who is British, while the administrative and teaching personnel are hired by the Headmaster or Superintendent who is in most cases American or British.

Currently, there are six international schools in Thailand, each reflecting a unique educational need. In Chiang Mai, the International School uses an American-based curriculum. In Bangkok, there is a French School, a Japanese School, and a British School (Pattana) each structured to reflect the academic requirements of the parent country. Ruam Rudee International School recently had two campuses; one uses an American-based curriculum, the other Swiss, taught in German. This year, Ruam Rudee moved into a larger complex. The International School Bangkok curriculum is American-based but also offers the International Baccalaureate program for students bound for European universities. A new international school is planned to open in Bangkok in August of 1992. Its founders will model it on United Nations schools in Geneva and New York, with a flexible curriculum to meet the needs of students from all parts of the world. It will not necessarily be based on the American curricular model.

In the United States, international schools have existed for some time (The United Nations School in New York and the International School in Washington DC are two of the more well-known), but Japanese schools are now being opened or planned in areas where Japanese-based industry has brought large numbers of Japanese businessmen and their families. The international school concept has been successful in meeting the needs of temporarily displaced students world-wide, and by all indications will remain a viable force in education for some time to come. While the modifications will continue to reflect student populations and shape curricula, the schools themselves will be a comfortable and familiar 'base' for young people far from home. If the international schools and host country schools were to develop a cooperative venture, such as student and teacher exchange programs, the understanding between cultures would be enhanced and the lives of children even more enriched.

Reference

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John Stiles is a PhD candidate in Science Education at the University of Iowa in Iowa City, Iowa (USA). As a teacher for more than eighteen years, he has taught in several locales, including American and International schools in Brussels, London and Bangkok.

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International Seminar Report
Empirical Research in Chemistry and Physics Education
10 – 12 June 1992

by Jan Hendriks, ICASE European Representative

In cooperation with ICASE, the University of Dortmund in Germany organised an interesting Summer Symposium. The first such summer symposium on Education in Chemistry in 1981 attracted little interest outside of the Federal Republic of Germany.

By cooperating with ICASE for the 1988 Symposium, the Summer Symposium was publicised worldwide. In recent years, the Dortmund Summer Symposium has developed into an internationally recognised meeting of researchers in science and mathematics education – a valuable source of information and ideas. The work and enthusiasm of Hans-Jürgen Schmidt, in particular, has been a key factor contributing to the success of the symposia.

In this year's Symposium, speakers from Australia, India, the Netherlands, Nigeria, the United Kingdom, the United States and Germany contributed to the program of lectures and discussions. About 80 participants focused on topics such as:
An Invitation to Kansas City
NSTA National Convention
March 1993

International Round Table

Each year at the NSTA National Convention, the International Committee of the United States National Science Teachers Association (NSTA) hosts an International Round Table. At this 90 minute session, presenters from different parts of the world discuss their country's science education programs.

Each presenter is provided with a table for a materials display. Those attending the International Round Table session visit the tables of countries they wish to learn about.

If you would like an official invitation to participate as a representative of your country, write to:

John E Penick
Science Education Centre
Room 789 VAN
The University of Iowa
Iowa City, IA 52242-1478
USA

Participants will be required to arrange their own funding. The letter of invitation, and your name listed in the program, may help you as you seek funding support.

For information about other conferences refer to the Calendar section in this issue
Commonwealth Association of Science, Technology and Mathematics Educators

HAVE YOU ENTERED FOR A CASTME AWARD?

Contact your local British Council Office for details, or write to:

CASTME Awards Scheme
c/o Education Department
Education and Science Division
The British Council
Medlock St
Manchester
M15 4PR, UK
INFORMATION SHEET

Commonwealth Association of Science, Technology and Mathematics Educators (CASTME): Awards for science, technology and Mathematics teachers 1992/93

1. Introduction

The CASTME Award Scheme was started in 1974 when CASTME (then CASME) undertook to develop the former Guiness Award Scheme. Many entries have been received over the years since it started. It is certain that some schools and individual teachers have received major professional stimulus through its activities.

The awards are intended to encourage teaching of the social aspects of science, technology and mathematics, with particular reference to developing countries of the Commonwealth. The scope of the awards is interpreted broadly, and 'social aspects' includes the relevance of science, technology and mathematics curricula to

☐ local needs and conditions

☐ the impact of technology, industry and agriculture on the local community.

2. Eligibility

Teachers and officials (advisers, inspectors, etc) working in primary, secondary and tertiary education in Commonwealth countries are eligible to enter. Individuals or syndicates may enter.

3. Topics

There are no set topics for the competition. Reports of work carried out by the teacher or official should be based on personal experience and should include a substantial account of teaching and/or other educational work, such as curriculum development or programmes of teacher training. Entries based on ideas, proposals or general arguments which have not been tried out in practice are not acceptable.

An example of a recent prize-winning entry was entitled 'Using reed - a no-cost material - for science experiments in a rural middle school'. The author teaches in a rural school with no laboratory or commercial apparatus. He describes how he and his students developed a wide range of experiments and investigations using reeds gathered from a nearby swamp. Examples of activity-sheets are included, links with both the environment and the prescribed science syllabus explained, and the effects of the approach described and evaluated.

Each entry must be the original work of the entrant and must not have been published previously.

4 Awards

In addition to a small money prize donated by CASTME, a few travelling fellowships are sometimes awarded at the discretion of the judges. These fellowships, a gift of the Commonwealth Foundation, enable the prize-winners to follow a short programme of professional visits in a Commonwealth country. Edited versions of all winning entries may be published in the CASTME Journal and short abstracts of winning entries are printed in The British Council’s Science Education Newsletter. All prize winners will receive twelve months free subscription of the CASTME Journal. The judges are appointed by the Council of CASTME and their decisions will be final.
Judging is based on the following criteria

☐ evidence of originality and creativity
☐ evidence of use in practice and cost effectiveness (entries based on ideas, proposals or general arguments which have not been tried out are unacceptable)
☐ evidence of evaluation of the idea or material in use
☐ evidence of the social relevance of the project
☐ standards of presentation, organization and structure of the report

5. Presentation of the entry

Only one entry can be accepted from any one individual or syndicate.

Entries previously submitted to CASTME may not be re-submitted.

The entry must be written or typed on one side of A4 or quarto sheets of paper, and should not exceed 10,000 words in length. Reports in the past have mostly been between 2,000 and 5,000 words long.

Photographs and other illustrative material should be included wherever relevant, together with any other evidence that shows the ideas have been effective in practice. Pupil’s work may be included where possible.

Reference should be made to the source of information or of original experiments wherever this is necessary to a proper assessment of proposed modifications.

If a substantial part of an entry is being published or submitted as a thesis, this should be mentioned on the top sheet of the entry.

6. Registration and submission

Registration must be made before 30 November 1992.

Entries from registered candidates must arrive in the Education Department, Education and Science Division of The British Council before 1 March 1993.

Intending applicants should fill in a registration form. These can be obtained from

☐ Their local British Council Office
☐ CASTME Awards Scheme, c/o Education Department, Education and Science Division, The British Council, Medlock St, Manchester, M15 4PR, UK
Is Chemistry a Male Domain?

by John Beard, Charles Fogliani, Chris Owens & Audrey Wilson

Have your secondary science or chemistry students participated in a national quiz? Why not challenge them with a quiz lasting 60 minutes? In 1991, over 64000 students in 850 schools in Australia and the South Pacific participated in such a quiz.

The Royal Australian Chemical Institute introduced a National Chemistry Quiz in 1982, with two papers: a Senior Paper (Years 11 and 12) and a Junior Paper. A third paper (Years 7 and 8) was introduced in 1989, and a separate paper for Year 11 is being introduced in 1992. Schools from Fiji, Papua New Guinea and all States of Australia participate. The number of students taking the Quiz has increased from 8750 (150 schools) in 1982, to over 64000 (850 schools) in 1991.

Each paper in the Quiz is non-syllabus based and contains thirty multiple choice questions designed to stimulate interest in chemistry. While offering a challenge to students the primary function of the Quiz is enjoyment rather than formal assessment. Some questions are also presented as crosswords or word puzzles.

Certificates of Excellence (certificate and plaque) are awarded to students who achieve 100% in the Quiz, and Awards of Excellence (a plaque) are given for other outstanding results. About 40% of all participants receive a Certificate of Merit (10% High Distinction, 15% Distinction and 15% Credit).

Expressions of interest from teachers in Australia and overseas have led to the production of two books of categorised multiple choice questions from past Senior and Junior Quiz papers. The questions in these books can be used by teachers to produce tests and examination papers containing a balance of questions which have been categorised using Bloom's Taxonomy (Bloom, 1956). Questions are categorised as: knowledge (recall); comprehension; application; or analysis.

A typical example of a question classified as 'knowledge' is:

Valuable insights on teaching and learning may be gained from research and it is the aim of this section to bring significant research information to the attention of science teachers, with a view to helping them in their important work.

A student carelessly dropped 18M sulfuric acid onto some paper. The student noticed that, within a few seconds, the paper became blackened. In this reaction, the sulfuric acid is acting as:

- A dehydrating agent
- B an acid
- C a base
- D an oxidant

An example of a question classified as analysis is:

When milk powder is mixed thoroughly with black copper (II) oxide and heated in a test tube, water vapour is formed, together with a gas that turns lime water milky. Some of the copper (II) changes to copper. This shows that milk contains:

- A carbon
- B carbon and hydrogen
- C hydrogen
- D water

No questions from the two higher Bloom categories, synthesis and evaluation, are included in either the Quiz or the books. Questions in these categories usually require essay type answers, but the National Chemistry Quiz is restricted to multiple choice questions, owing to the difficulty of assessing such a large number entrants.

In comparing the performance of students in Years 11 and 12 on the 1989 to 1991 quiz papers, the percentage of Year 12 students who chose the correct answers nearly always exceeded the percentage for Year 11 students. This result is to be expected as Year 12 students have studied chemistry for an extra year. This has made it difficult to set a paper which is suitable for both Year 11 and 12 students, particularly as the Year 11 chemistry students in different states in Australia are taught various topics. To overcome this problem, a separate paper for Year 11 students, which will be more appropriate to their knowledge base, is being introduced in 1992, as mentioned above.

A more detailed examination of the performance in 1991 of final year secondary school students (Year 12) shows four questions where the overall performance was low (only between 15% and 30% correct responses). One of these, Question 20, involved reading the scale from a diagram of a burette. The question students found most difficult, however, was Question 26, and it involved the depression of the melting point of a pure substance by the addition of another substance. This was a question requiring only recall information and, as such, did not indicate lack of understanding or ability to reason.

The 1991 Senior Quiz Paper contained five questions classified as analysis.
Table 1: A summary of mean percentage of each Bloom category correct for the three 1991 papers. Values in brackets indicate number of questions in category.

<table>
<thead>
<tr>
<th>Year</th>
<th>Knowledge</th>
<th>Comprehension</th>
<th>Application</th>
<th>Analysis</th>
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<tr>
<td>7</td>
<td>32.7 (10)</td>
<td>49.3 (14)</td>
<td>30.8 (5)</td>
<td>23.2 (1)</td>
</tr>
<tr>
<td>8</td>
<td>38.1 (10)</td>
<td>55.2 (14)</td>
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<td>28.2 (7)</td>
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<tr>
<td>12</td>
<td>40.2 (5)</td>
<td>44.5 (7)</td>
<td>64.2 (13)</td>
<td>51.9 (5)</td>
</tr>
</tbody>
</table>

(Table 1), which involved the highest cognitive skills of the four categories used. The students' performance on these five questions was quite good with Year 11 scoring 40.8% correct and Year 12 scoring 51.9%.

Fewer females than males in Years 11 and 12 participated in the 1991 Quiz, although more Year 12 Chemistry students are female (Australian Bureau of Statistics, 1990). In contrast more females than males in Years 7-10 participated in the 1991 Quiz. Table 2 (opposite) shows the percentage of males and females, and the mean percentage scores for each gender and year group in the 1991 Quiz. The males consistently achieved a higher mean score in the 1991 Quiz for all Years 7-12.

Application of a 't' test to the mean group scores, standard deviations, and number of students in each Year for males and females shows that the means for males and females are statistically different with p<0.001. The null hypothesis that there is no difference between the two scores is invalidated. In the 1991 Senior Paper males scored an average of 5.9% more than females in Year 12 on 27 of the questions and 5.5% more in Year 11 on 25 of the questions.

It is interesting to consider the significance, if any, of these results. For example, do the results mean that males are better at answering chemistry questions than females? Or are they simply an indication that a higher proportion of females in Australia who are weaker at chemistry are sitting for the Quiz? The samples of males and females taking the Quiz are not random or equivalent as only some schools out of the total national school sample are involved in any year, and most schools do not enter all their students. Table 3 (opposite) summarises the numbers of males and females in the top 150 for each year group in the Quiz, and it shows that the number of males is higher in each case.

Table 1 shows clearly that in each of the Quiz Papers the higher the Year Group (ie Year 12, 10 and 8) performed better than the lower Year Group. The increased achievement of the older students is not only on recall but also in the more important higher order cognitive skills. The origin of this increased understanding and chemical knowledge is not easily determined but it seems likely that the additional chemistry studied would be an influence. The significant increase in cognitive achievement in chemistry is

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Dr Jack Holbrook, Executive Secretary
Department of Curriculum Studies
University of Hong Kong, Hong Kong
<table>
<thead>
<tr>
<th>Year</th>
<th>% Males</th>
<th>% Females</th>
<th>% Mean Males Group Score</th>
<th>% Mean Females Group Score</th>
<th>Difference in (Males-Females) Group Score</th>
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</thead>
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<tr>
<td>7</td>
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<td></td>
<td></td>
<td>5.0</td>
</tr>
</tbody>
</table>

*TABLE 2 (Above): Percentage of males and females participating in 1991 Quiz papers, and the mean percentage score for each group*

<table>
<thead>
<tr>
<th>Year</th>
<th>No. of Males Entered</th>
<th>No. of Females Entered</th>
<th>No. of Males in Top 150</th>
<th>No. of Females in Top 150</th>
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<td>5241</td>
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<td>3683</td>
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<td>1399</td>
<td>1615</td>
<td>97</td>
<td>53</td>
</tr>
</tbody>
</table>

*TABLE 3 (Above): Comparision of male and female performance in the 1991 Australian National Chemistry Quiz for the top 150 students in each year*

welcome and encouraging. However, the consistency of gender related mean performances over Years 7 to 12 needs to be investigated further.

**References**


Australian Bureau of Statistics (1990) *National School Statistics Collection Schools in Australia*

**About the authors**

John Beard and Charles Fogliani can be contacted at Charles Sturt University – Mitchell. Chris Owens can be contacted at the University of Western Sydney – Nepean. Audrey Wilson comes from the University of Wollongong.
The Necessity of Variety in Teaching


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Ronald J Bonnstetter
Center for Curriculum and Instruction
University of Nebraska
Lincoln, Nebraska 68588
USA

We all know that ideally we should individualise our instruction. Realising that in most cases this is not feasible, we tend to dismiss the goal and teach as we were taught or teach using approaches that best fit our own personal learning style. This column will review current learning theory research and point out the need to teach every major science concept using at least three learning approaches.

Over the years we have found that not only do people learn in ways that differ dramatically, but certain students understand only when material is presented using their preferred learning style. Reckinger (1979) found that if our students' learning style is oral, visual, kinesthetic, or any of the many combinations of diverse elements that make up personality and learning styles, their chances of succeeding in a science program that is dominated by lecture are close to zero. Recent studies suggest that the United States population may be 10-20% oral learners, 20-30% visual, and as much as 30% kinesthetic. In other words, at least half of US students learn best by doing.

And yet most teachers present information using their own preferred learning style. (Marshall, 1991). Local research on pre-service secondary science majors at the University of Nebraska have found that up to 80% of any given methods class can be classified as intuitive-thinkers while Myers-Briggs Guide to the use of type (1985) found less than 15% of secondary students are of this type. This means that most of our students need to experience a concept, while most of my future science teachers thoroughly enjoy mentally constructing knowledge. The fear is that these teachers will expect their students to learn intuitively. One can easily picture these teachers saying, "We don't have time to mess around with every concept in the book. Besides, the information is obvious and I don't have time to set up all that equipment."

There are several broad spectrum approaches to applying learning style information to teaching. The approach that may best fit our present limited knowledge and resources, takes into account the need to create diverse learning experiences in both curriculum design and instruction. According to Joseph Bogen (1975), most individuals rely on one information processing mode more than others, especially when approaching new learning. Bernice McCarthy (1990), suggests that several major learning styles should be addressed when introducing new concepts, thus allowing learners to experience the concept through their learning style strength and yet be stretched and challenged by other approaches.

In action this means that each new science concept should be presented using a minimum of three strategies that offer opportunities for visual learners, oral learners, and kinesthetic learners.

This section focuses on the pre-service and in-service education of science teachers, and aims to communicate ideas and strategies which will assist science teacher educators to enhance and enrich their pre-service and in-service programs.

Teach with variety

The philosophy of offering variety can prevent some of the problems of science teachers teaching only as they prefer to learn. A review of the literature makes several clear statements:

- Individuals learn in different ways or styles.
- These styles can many times be identified by some form of inventory or through direct observation.
- An individual's learning style makes a difference in how and what they learn.
- Individuals learn best when they are taught in a mode congruent with their individual learning style.
- Awareness of learning styles makes a teacher more receptive to student needs and problems.

By studying learning styles, teachers develop a better awareness of why some things work with some learners while not with others. At the same time, when diagnosing learning styles we must be careful not to over generalise and pigeon-hole students. Learning style research is not the only variable at work in our classroom.

Both teacher and learner must continue to work at being flexible and able to adapt to a variety of teaching methods and learning styles. By adapting our lessons to accommodate multiple instructional strategies, we are far more likely to teach to our students' preferred learning style. Let's not continue to only allow people who learn as we do to succeed in science. We can meet the needs of far more of our students by putting variety in our teaching.
References

Bogen J (1975) Some educational ramifications of hemispheric specialization. UCLA Educator 17 24-32


Myers B & McCaulley M. A guide to the development and use of the Myers-Briggs type indicator Consulting Psychologists Press, 577 College Avenue, Palo Alto, CA 94306

Reckinger N (1979) Choice as a way to quality learning Educational Leadership Vol 36, 255-256

Literature Review


Dunn R (1990) Rita Dunn answers questions on learning styles Educational Leadership Vol 48 No 22, 15-19


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This valuable resource book (166 pages) provides information about the activities and facilities available at the Pasteur Institute. It contains a variety of science experiments relating to the action of soil microbes, yeast as a food-making microbe, micro-organisms in milk, making cheese, making vinegar, and making wine, to name just a few.

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Science Education in Primary Schools
Sri Lanka

by L S Kuruppu

This paper was presented at a Seminar preceding the 8th ICASE Symposium held in Sri Lanka.

Introduction

'The complete eradication of illiteracy and the assurance to all persons of the right to universal and equal access to education at all levels.' Thus says the Constitution of the Democratic Socialist Republic of Sri Lanka.

This has guaranteed the right of equal opportunities for education for all up to university level.

According to the 1990 school census, out of a total of 10100 schools, 96% had primary grades. This is an indication of the spread of Primary Education facilities throughout the country. The size of the school varies from less than 50 pupils to over 4000. These schools are mostly situated in the remote rural areas and in the plantation sector. 24% of the total number of schools fall into this category.

78% of schools have a student population of less than 500. School census reports show that male enrolment in the primary cycle is slightly higher than the female enrolment. Annually the enrolment rate has increased.

There are many reasons for this fact. There is a widespread interest about the schooling of the children, and in the new settlement areas, the number of schools has increased from 8100 in 1975 to 10100 in 1990 (School Census). As a result, there is now a school within two miles of every student in the country. Under the free education scheme no fees are levied from students in government schools. Text books have been given free to all students from Year 1 to Year 11 since 1980 and a free mid-day meal has been given since 1989. As a result, participation in education has increased.

The proposed free uniforms for all children from January 1993 will add to the improvement of participation rates. Participation in education has increased from 1.9 million in 1979 to 2.2 million in 1988 and 2.5 million in 1990 (School Census). The pupil cohort of 100 graduating from the primary sector has increased from 576 in 1971 to 911 in 1988. The number of years to graduation from primary level has decreased from 9.56 in 1971 to 6.11 in 1985.

Primary Science Education

Teaching science at primary level actually began with the introduction of a new subject called 'Nature Study' in 1954. This was the first policy decision at the national level to introduce science in primary schools. During the curriculum revision that took place in 1972, a new teaching strategy was introduced—integrated teaching, child-centred and emphasising the development of skills and attitudes as well as content. This new curriculum implemented a core subject 'Environmental Studies'. This paved the way for scientific investigations and the introduction of scientific method. This subject integrated basic concepts of Aesthetics, Creative Technological fields, Geography, History, Health, and Civics with science. The studies were based on eleven themes derived from opportunities and facilities available in the students' immediate environment.

During the next curricular revision (1982), which was based on the White Paper Proposals of 1981, the science component was separated from Environmental Studies and a new subject, called 'Beginning Science', was introduced at Year 4 level.

The content of this subject was selected to include simple terminology so that primary teachers would be able to create activities for the children. No textbook was made available and the children were expected to be involved in observations, explorations, collecting data and identifying scientific patterns in the environment. This child-centred teaching strongly reflected Piaget's work.

During the implementation of this

How you can help with Phase 1 of Project 2000+

Science teachers associations and other ICASE member organisations can play an important role in Project 2000+. Material relating to one or more of the following areas is needed:

- The nature of and the need for scientific and technological literacy
- S&T literacy for development
- The teaching and learning environment for S&T literacy

- Teacher and leadership education for S&T literacy
- Assessment and evaluation of S&T literacy
- Nonformal and informal development of S&T literacy

See note about where to send your contributions on page 3 of this issue.
program, certain issues became apparent. Firstly, it was difficult to orient the teachers to the new methodology in this program. Under privileged primary schools (24%) had very few teachers and fewer facilities with little motivation for implementing innovative learning programs. Although as many as 80% of primary children enter secondary education, many of them do not exhibit necessary attitudes and understanding of basic concepts.

National Seminar

SLASME Committee held a National Seminar on Primary Science as a pre-symposium seminar to the 8th ICASE Asian Symposium. The Director General of the National Institute of Education organised and financed this seminar. 20 teachers and senior Primary Science Inservice Advisors focused on the following areas:

* Impact of socio-economic factors on science education
* Primary science policy
* Innovative teaching methods including self-learning activities, guided investigation, dramatisation and role play
* Methods of evaluation

The teachers worked in eight groups each led by a District Inservice Advisor. In the six months prior to the seminar, trials were held in schools and the outcomes presented at the seminar. In the Keynote Address, the Director General explained how children must be set free to make their own discoveries and so achieve understanding. To achieve this, the teacher employs active exploration, investigation, and inquiry into the environment in which they live and work. Above all children need inspiration. The teacher's role is to make the learning experience more meaningful and inspiring to the child.

Impact of socio-economic factors on science education

This study was done to examine the relationship between the socio-economic status of the child and the achievement level of the child. A sample of students was selected randomly from seven education districts, and a survey made of their socio-economic background using a questionnaire. This data was then compared with their achievement in learning science.

The results indicated a strong correlation (78%) between socio-economic level and learning achievement, that is high achievers were generally of a high socio-economic level, whilst low achievers were from a low socio-economic level. Only 4% of high achievers had a low socio-economic background while 18% of the low achievers had a high socio-economic background. Where a low achiever came from a high socio-economic background, the parents were found to have comparatively low education levels. In the few exceptional cases of high achievers of a low socio-economic background, it is possible that the education level of the parent played a positive role. A past study of NIE (Entry Competency of Sri Lankan Children, NIE 1988, p.257) states:

'It is evident from the data that the occupation and education of parents does play an important role with respect to their children's educational achievement. Further it was revealed that it is the mother's education that matters the most . . .

Whatever the validity of the conclusions of this study, it opens up the opportunity to further probe into the factors influencing the learning of the Sri Lankan child.

Self-Learning Strategies

Guided observations

Children see many things, but only a few investigate these further. Teachers and facilitators can be of tremendous help in furthering the natural curiosity of children. For example, an after school Science Club activity might have a teacher probing the factors promoting the decay of leaves. Children might be assisted to investigate commonly held beliefs about the natural world – for example, two different varieties of the Jak tree may be distinguished by their falling leaves.

Workbooks with audio-tapes

An audio-tape can be used to give further instructions to children working through activities in a workbook. These kits can be used when the teacher is absent.

Crossword puzzles

The booklet suggests reading and experiments to do. The skills and knowledge that are gathered are used in solving the series of puzzles found in this kit.

Children learn in different ways

Various books have been produced under this project to add variety and interest to classroom work. Some of the books carry suggested assignments and overlay illustrations so that

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What you can contribute to Phase 1 of Project 2000+

Guidelines for the type of materials to contribute to Phase 1 of Project 2000+ are as follows:

Do contribute teaching ideas for scientific & technological literacy, including videotapes, computer programs, examination papers, slides, questionnaire results relating to scientific & technological literacy (and curricula), position statements, etc.

Do not contribute material which is not applicable for learning in the year 2000, or material related to the advancement of content only, or current teaching materials that do not relate to science & technology education.

You may wish to establish a task force to help you with this task.

Please send contributions to the contacts listed on page 3 of this issue.
diagrams can be separated into their components – for example, the parts of a flower.

Guided investigations

The child's natural curiosity can be harnessed to motivate children in learning. Children may make an observation and a subsequent discussion might provide opportunity for them to make an hypothesis. Further investigations at times end up in wonderful discoveries as well as teaching the child the important skills of hypothesising and testing.

For example, a child found a household beetle and, observing it closely, he found some small creatures on its body. He, his friends, and even his parents, thought these were the young of the beetle. A teacher suggested further investigation and they discovered that their hypothesis was wrong - the small creatures were, in fact, bugs.

Researchers have identified the following features in children's investigations

- there is a process of logical thinking and reasoning that emerge from experience
- guidance could enrich or promote this process of observation and reasoning
- media, including textbooks can influence children's investigations
- often children's explanations are not perfect, but are very significant in arriving at conclusions
- achievement motivates children

Dramatisation and role play

Nature, which is full of patterns and cycles, is the true site for children's science. Once children observe and enjoy their natural surroundings they develop an enquiring and confident motivation towards learning. This can be enhanced by dramatisation which brings about the integration of Aesthetics and Language Development with Science. Various systems can be dramatised to great effect by children. The group presented a musical play on 'dispersal of seeds', on 'how an electric circuit works' and on 'how the different parts of a tree work together'.

Evaluation in primary science

Traditional evaluation is a drudgery for students. New techniques of evaluation are needed so that the love of learning is not destroyed. Some of the following are suitable alternatives for Primary Science.

- Role Play - the teacher, or group of children enter a class wearing masks symbolising objects and question the children about the topic presented. For example, a tree might ask children about its functions - children receive rewards for correct responses.
- Worksheets - children are given genuine specimens and a worksheet where questions are given. Colours are given to ascertain their performance level
- Observation - the teacher gives the children a few clues about a plant, an animal or an event. The children have to find it and subsequently complete a worksheet

Approaches to assessment include:

1. Manipulative skills/measurement – weighing balances have been improvised by the teacher. Students use them to find out the mass of objects provided. In a similar way, students can be asked to measure volume or length.
2. Skills in collecting/interpreting data – assignments can be given to student groups in advance. For example, what happens to a flower before it turns into a fruit? Daily observations can be recorded to provide continuous assessment. After the assignment is completed, the products are displayed for other children to see.

Conclusions

In Sri Lanka, as in many other countries, the teaching of science in primary schools is new. Hence, it is too early to set in concrete methodology or content of science at this level.

Recommendations

- Science education policy development must take into account living conditions, the richness of the environment, the benefits of learning science, and the contribution of science to the quality of life.
- Facilities/opportunities, in and out of school, must be available to engage children in investigative activities.
- The content and approaches to science in the primary school must be diverse and appropriate for the locality.
- Evaluation at the primary level should not hinder children's natural curiosity and activity.
- Innovative teachers are an asset to the teaching of science at the primary level. Teacher training programs need to provide teachers who are innovative.
- The innovative work by teachers should be taken into account for teacher promotion.

Mr L S Kuruppu is Director, Department of Primary Education, NIE, Sri Lanka.
AIMS
Stepping into Science is an ICASE project which aims to:
• Establish an international network for teachers to share ideas on the teaching of primary/elementary science and technology.
• Provide activities and support for teachers, thereby encouraging them to include more science in the primary/elementary curriculum.
• Promote the value of science experiences for young children throughout the world.
• Facilitate professional development opportunities for teachers by including sessions on primary science and technology in regional and international conferences.

ACTIVITIES
The Stepping into Science Team is actively involved in a number of projects and activities including:
• Publishing STEPS, the Stepping into Science Project Newsletter. This newsletter contains ideas for class activities at various levels in primary/elementary schools, activities for children to do at home, comments by network members on issues, examples of children’s work, lists of helpful resources and contacts. ICASE acknowledges the contribution of Philip Harris in sponsoring STEPS.
• Contributing articles and ideas for the Primary Science Section in Science Education International, the ICASE quarterly journal.
• Compiling ideas and activities for inclusion in a series of sourcebooks on the teaching of primary/elementary science and technology.
• Coordinating a scheme to encourage children to participate in science and technology activities. Certificates of Participation have been produced, and are available for schools to use in rewarding students as they complete a number of activities. Certificates are colour coded in seven different colours, so that they can be used to acknowledge progress in science from early to advanced levels within primary/elementary schools. ICASE is grateful to BP (Oman) for sponsoring this scheme.
• Organising Stepping into Science workshops and displays of children’s work at national, regional and international conferences.

FOR MORE INFORMATION
Contact the Project Officer:
Sue Dale Tunnicliffe
ICASE Project Officer
Stepping into Science Project
18 Octavia, Bracknell
Berkshire RG12 7YZ
Resources

Australian Chemistry Resource Book
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Edited by C. L. Fogliani

The 1992 Volume of the Australian Chemistry Resource Book is now available. This edition has been enhanced in response to a teacher survey conducted about the value of the 1991 Resource Book which is published annually on the occasion of Australian National Chemistry Week organised by the Royal Australian Chemical Institute. Teachers indicated that they found the book useful and that it should be continued to be produced. Although teachers were generally satisfied with the type of articles published, some indicated that they would like articles suitable for students in the junior years. This year, the Resource Book includes articles such as A Metal’s Tale and Chemical Bonding and the Structure and Properties of Materials which will be of general interest to junior students. The number of pages has been increased from 120 to 210 as a result of the positive feedback.

Send order with A$10.00 payment to:
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ICASE PUBLICATION
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1991 Edition

INTERNATIONAL COUNCIL OF ASSOCIATIONS FOR SCIENCE EDUCATION

Who's Who in Science Education Around the World

Published by ICASE
With assistance from UNESCO
1991 Edition

This new ICASE publication, published with the assistance of UNESCO, contains brief profiles on prominent science educators, their work, their projects and their interests. The valuable reference book includes key women and men in many countries throughout the world who are contributing to science education at primary, secondary or tertiary levels.

The information will help readers to contact colleagues in both developing and developed countries who may be working on projects of interest to them, who may be potential speakers at upcoming meetings or conventions, and who may be invited to work on collaborative projects.

Copies at a cost of US$15.00 or £9.00 or A$20.00 including postage can be ordered from the Editor:
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10 Hawken Street, Monash, ACT 2904, Australia

or

Dr Jack Holbrook, Executive Secretary, ICASE
Dept of Curriculum Studies, University of Hong Kong
Hong Kong

Dennis Chisman, Honorary Treasurer, ICASE
Knapp Hill, South Harting, Petersfield GU31 5LR, UK
Cheques payable to “ICASE”
Popularisation of Science and Technology
What Informal and Nonformal Education can do?
Edited by
Cheng Kai Ming & Leung Kam Fong

This publication is a report of an International Conference organised by the University of Hong Kong in cooperation with Unesco. The 205 page proceedings of the 1989 conference contains a selection of papers which focus on how nonformal and informal education can contribute to helping people achieve a level of scientific and technological literacy.

NOW AVAILABLE
1992 ICASE Yearbook
The Status of Science Technology Society Reform Efforts Around the World

FOREWORD
Science Technology Society attracts even more attention than it did in years ago when it became a new focus for reform in a few nations like the United Kingdom, The Netherlands, and, to a lesser extent, the United States. Currently it is a focus in nations on every continent. For many it represents the most significant change seen in classrooms during this century. For some the reform seems slow – not to be realised to any degree before the year 2000.

This Yearbook has been prepared as a means of updating science educators and ICASE member societies around the world. Hopefully it will help coalesce the concept in all nations and provide support for emerging projects in other nations. The reports are offered in the spirit of providing a status statement. Also, information is included that can be used as evidence for STS as real reform. Hopefully such evidence will be useful for schools and the most innovative and creative teachers in science societies who are struggling with STS in their own situations. The Yearbook is organised as:

STS definitions and rationales
Examples of STS initiatives
Evaluation of STS efforts
STS moves in various nations

The authors all hope their contributions provide useful information and suggestions. They all hope that the Yearbook provides a needed record of where we are while also being controversial enough to promote debate and dialogue.

Sourcebook in Environmental Education for Secondary School Teachers

Published by Unesco

This sourcebook (316 pages) is the product of a regional training course organised by Unesco in the Phillipine in 1989. Published in 1992, it contains knowledge base as well as pedagogical aspects of environmental education through presenting exemplary lesson plans and evaluation mechanisms.

For further information, write to:
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Post Office
Bangkok 10110
Thailand

Towards Formulating Goals, Aims and Objectives of Secondary Education for the Twenty First Century

Published by NIER

Published in 1991 (95 pages), this is the final report of the Regional Seminar on the Goals, Aims, and Objectives of Secondary Education in Asia and the Pacific which was held in Tokyo, Japan and organised by the National Institute for Educational Research (NIER).

To obtain this report, contact:
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ICASE is keen to arrange regional or world events for the benefit of member associations. If your association or organisation is interested in hosting an international seminar, workshop or conference, contact the Executive Secretary or your Regional Representative. To gain ICASE endorsement, the meeting must be international in nature, open to member associations, and, while all sectors of the science education community should be encouraged to participate, must be relevant to classroom teachers.

1992

September 19-21
Second General Conference of Teachers
Location: Poland
Contact: SNPPiT, Skrytka Pocztowa 62, 85-791 Bydgoszcz 32, Poland
This second General Conference on the theme 'Education, Environmental Protection and Industry' is being organised by the Association of Science and Technology Teachers (SNPPiT), Poland. Languages used will be Polish and English.

December 17-21
Twelfth International Conference on Chemical Education
Location: Bangkok, Thailand
Contact: Dr Somjai Wichaidit, The Secretariat - 12th ICCE, c/o Research Centre, Faculty of Medicine, Ramathibodi Hospital, Rama 6 Road, Bangkok 10400, Thailand
The theme of the Twelfth International Conference on Chemical Education will be *Chemistry in Transition* and it is hoped that the participants will interpret this in many different ways. This biennial Conference, to be held for the first time in South East Asia, is organised by the Committee on Teaching of Chemistry of the International Union of Pure & Applied Chemistry, and The Chemical Society of Thailand in cooperation with UNESCO. It is attended by chemistry teachers at both high school and university levels who wish to improve their teaching and to learn from one another techniques and experiences. A second circular including instructions for submitting abstracts is now available from the address above.

November 11-12
Second ICASE Education-Industry Symposium
Location: AKZO Centre, Arnhem, The Netherlands
Contact: Drs Jan Hendriks, ICASE European Representative, Konijnpad 3, 7921 BM Zuidwolde (DR), The Netherlands, Fax 31-5287-2693
AKZO, one of the leading chemical and pharmaceutical industries in Europe, is hosting this second symposium on Education-Industry partnerships. The program consists of 4 half-day themes: (1) New and current projects; (2) Models for evaluating partnership programs; (3) Extending partnerships to involve publishers, media, museums; (4) Workshops to define future priority areas. Participation by invitation only.

1993

January 3-6
ASE Annual Meeting
Location: Loughborough University, UK
Contact: Annual Meeting Secretary, ASE Headquarters, College Lane, Hatfield AL10 9AA, UK
Full details of this large international event will be circulated in *Education in Science*, a journal of the Association for Science Education.

January 3-8
International Conference on Science Education in Developing Countries
Location: The Amos De-Shalit Israeli Science Teaching Center, Israel
Contact: Conference Secretariat, ORTRA Ltd, 2 Kaufman St, PO Box 50432, 61500 Tel-Aviv, Israel (conference arrangements) or Dr Avi Hofstein, Department of Science Teaching, The Weizmann Institute of Science, Rehovot 76100, Israel (academic correspondence)
This international conference on the theme "Science Education in Developing Countries: From Theory to Practice" will review past experiences and achievements in science education and plan for the 21st century with a special focus on developing countries. The conference will feature plenary lectures, symposia, poster sessions, workshops, exhibitions, informal discussions, social events and local visits. Topics for symposia and plenary lectures will focus on current research on learning and teaching and its implications for (1) the learner, (2) the teacher, (3) the classroom, and (4) the curriculum.

March 21 - April 2
Science Education in a National Curriculum: An International Symposium
Location: University of York, UK
Contact: Your nearest British Council Office or Courses Department, The British Council, 10 Spring Gardens, London SW1A 2BN. There are vacancies for 30 participants.
Topics include: building a national curriculum; new science curricula in secondary schools; styles of curriculum development; evaluation of science curricula; impact and research on developments in science curricula; student assessment; changing demands for staff development; links between industry and science education; the role of national and international agencies in science education.
March 25-30
Sixth International PATT Conference
Location: Motel Eindhoven, The Netherlands
Contact: dr. Marc J de Vries, Pedagogical Technological College, PO Box 826, 5600 AV Eindhoven, The Netherlands, Fax 31-40-440045.
The aim of this conference is to exchange ideas and information on theoretical and practical implications of the implementation of environmental issues in technology education according to the subthemes: (1) Pupils' attitudes towards technology and the environment; (2) Environmental issues in primary and secondary technology education; (3) Gender aspects of environmental issues in technology education; (4) Environmental issues in the education of technology teachers. Registration forms and abstracts of papers should be sent before 1 November 92.

April 21-25
International Conference on Geoscience Education and Training
Location: University of Southampton, UK
Contact: Mrs Esther Johnson, GEOED Conference Secretariat, Department of Geology, University of Southampton, Southampton S09 5NH, UK
The Association of Geoscientists for International Development (AGID) and the Commission on Geoscience Education and Training (COGEOED) of the International Union of Geological Sciences are convening this international conference with the support of ICASE. Themes include: geoscience education in schools; higher education; geoscience training for business, industry and public service; and public understanding of geoscience. The conference is open to all those with an interest in geoscience education and training - including practitioners and those involved in administration, course development, and the supply of resource materials.

June 27 - July 3
VII Pacific Science Inter-Congress
Location: Okinawa Convention Center, Okinawa, Japan
Contact: VII Pacific Science Inter-Congress, c/o Section of International Affairs, University of the Ryukyus, 1-Senbaru, Nishihara, Okinawa, 903-01, Japan
The Symposium will be organised around the theme The Pacific: Crossroads for Culture and Nature and subthemes (1) Cultural Interchange among Pacific Peoples; (2) Speciation, Dispersal and Conservation of Species in the Pacific; (3) Towards Appropriate Technologies and Policies for Development and for the Conservation of Natural Environments in the Pacific. Scientific sessions organised by the Scientific Committees of the Pacific Science Association focus on a range of science disciplines and issues, including Science Communication and Education.

July 5-9
CONASTA 42
Location: Sydney, Australia
Contact: Jenny Jones, Convener CONASTA 42, PO Box 787, Potts Point, NSW 2011 Australia
The Australian Science Teachers Association invites you to participate in the forty second annual conference of the Association. The theme of 'Science – Teaching it Better!' aims to highlight the part that teachers can play in fostering in their students an interest in and understanding of science. Four subthemes will deal with both primary and secondary issues: (1) Science updates - recent exciting developments and their impact; (2) Science education research - what it has to offer the classroom teacher; (3) Science teaching for effective learning - how do we engage minds in the classroom?; (4) National initiatives. The program includes theme lectures, interactive workshops, seminars, field workshops, 'wandertimes' and poster presentations. A comprehensive display of resources useful to science teachers will be presented by publishing, audiovisual, equipment and computing companies.

July 6-11
Project 2000+ International Forum
Location: Paris, France
Contact: Dr Jack Holbrook, ICASE Executive Secretary, Department of Curriculum Studies, University of Hong Kong, Hong Kong
This worldwide conference, organised by ICASE in conjunction with Unesco and other international bodies is the second phase of the three phase Project 2000+ (refer to article in this issue for more details of this project). A number of international and regional conferences are generating input into this international forum. The theme of the forum addresses the issue of Scientific and Technological Literacy for All. Sessions will establish agendas for future action. Attendance will be by invitation only (500 participants). Names are now being sought from a wide variety of organisations with an interest in science and technology education (see next page). The forum plans to issue statements to affect political visibility for science and technology education for all as a requirement for national development, and provide a framework for major programs of action in science and technology education involving governments, IGOs and NGOs.

July 27 - August 10
London International Youth Science Forum
Location: London, UK
Contact: LIYSF, PO Box 159, London SW10 9QX, UK
The Science Forum is the principal annual meeting in Britain of young scientists. Over three hundred students attend from some fifty nations to make this an international event of major significance. The program features lectures, seminars and demonstrations from leading scientific names, and an extensive range of visits to university and industrial research establishments.
International Forum

Scientific and Technological Literacy for All

Phase 2 of Project 2000+

Paris, France
6-11 July 1993

This International Forum is the Second Phase of Project 2000+, an international project on scientific and technological literacy for all, which addresses the following 6 focus areas:

1. The nature of, and the need for scientific and technological literacy
2. Scientific and technological literacy for development
3. The teaching and learning environment for scientific and technological literacy
4. Teacher education and leadership for scientific and technological literacy
5. Assessment and evaluation for scientific and technological literacy
6. Non formal and informal development of scientific and technological literacy

Attendance will be by invitation only and limited to 500 participants. Names are now being sought from:

- National EFA (Education For All) Groups
- National policy makers overseeing science and technology education
- INISTE centres
- Project coordinators and field workers for organisations
- Science and technology teacher associations
- Institutions, centres, universities and colleges involved in science and technology curricula, examinations and teacher education
- Science and technology out-of-school centres and organisations
- Non formal science and technology educational organisations
- Industrialists
- Persons from the mass media interested in Project 2000+

Organisations, associations and institutes are invited to submit names of suitable participants to the Project 2000+ secretariat before the end of September 1992. A short description of each person should also be included covering:

(a) activities of the person nationally (within organisation if appropriate)
(b) international involvement (at conferences, research, projects, etc)
(c) which Project 2000+ focus area is of greatest interest

Individuals can also apply. Individuals will be selected based on paper abstract, submitted by the end of September 1992, related to one of the focus areas.

Selection will take place at the end of 1992 and will be finalised by approval of the Steering Committee at the end of January 1993.

There will be a US$100 Registration Fee for each participant to help defray material costs. This will be payable to the Project 2000+ Secretariat on receiving the invitation. For further information, contact: Dr Jack B Holbrook, ICASE Executive Secretary, Department of Curriculum Studies, University of Hong Kong, Hong Kong.
Extending and improving education in science for all children and youth by assisting member associations throughout the world

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Science Education International is the Quarterly Journal of the International Council of Associations for Science Education. ICASE was established in 1973 to extend and improve education in science for all children and youth by assisting member associations throughout the world.

This journal provides a means for associations, institutions, centres, foundations, companies and individuals concerned with science education, to share perspectives, concerns, ideas and information which will foster cooperative efforts to improve science education, and which will serve as a chronicle of the advancement of science education throughout the world.

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Issue: Closing Date:
March 1 February
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September 1 August
December 1 November

ICASE News

Feature Articles
Project 2000+ Revisited J B Holbrook
The Present and Future of Science Education in Pakistan W J Boone & A Q Tahir
Role Play in Science Education A Weerasinghe
Reflections of Russia G Krockover

Science Education Around the World

Research for Teaching and Learning
A look at two minority families and their beliefs about who can become a scientist J E Nesbit

Primary Science
The Good Primary Science Teacher: What some Bruneian school children say C P Tendencia

Science Technology Society
International Model Solar Car Challenge

Resources

Calendar

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Knapp Hill, South Harting, Petersfield GU31 5LR, UK
Individuals £9 per annum, Libraries £18 per annum

or to one of these subscription centres:
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Science Education Center, University of Iowa, Iowa City IA 52242, USA
Individuals US$15 per annum, Libraries US$30 per annum

Brenton Honeyman, Editor, The ICASE Journal
10 Hawken Street, Monash ACT 2904, Australia
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1992 ICASE Distinguished Service Award presented to Samuel 'Tunde Bajah

The 33rd Annual Conference of STAN (Science Teachers Association of Nigeria) during August 1992 was the venue for the presentation of this prestigious award.

The Distinguished Service Award was awarded to Professor Bajah for his career history of distinguished service to international science education through his involvement in international activities of local, regional and global science education organisations. He becomes the first person from Africa to be awarded this honour, and joins a distinguished band of 9 previous recipients of this award.

In his acceptance speech, Professor Bajah said

"I ... receive this award with the greatest humility. I receive it for this great country which over the years has provided the arena for my exploration into science education; for my university, Ibadan, for the academic challenges it gave me; for my secondary school, Hussey College Warri, for the foundation it gave me in science; for my little village, Ugwuangwe, for the constant reminder to me that even small can be excellent; for my mother, Omeresan, of blessed memory who like most Iskiri women invested all she had to see me through school; for my wife, Ag, children and friends who kept putting the pressure of reassurance in my activities. I receive it for STAN, the Association I was privileged to serve and which had the confidence to dare ICASE with my credentials. Finally, I receive this prestigious honour, the first to Nigeria on behalf of humanity and all it stands for."

Photo below: Professor Samuel 'Tunde Bajah, FSTAN, the winner of the 1992 ICASE Distinguished Service Award

Fiji Association of Science Teachers joins ICASE

ICASE welcomes the Fiji Association of Science Teachers (FAST) as a Full Member. Vijendra Prakash, Secretary of FAST has provided the following information about this new association:

FAST was officially launched in December 1991 (having been formed as an interim body in August of that year) by the Permanent Secretary for Education. The launch also featured a display of resources and teaching aids.

In April of this year, the Association issued its first newsletter to help inform the public about the Association's activities and progress. In September, the Association was given an opportunity to address the Fiji Principals’ Association. At this meeting, FAST shared its goals and invited principals to support the Association by encouraging their staff to join FAST.

Future plans include:

- an annual convention on 20th January 1993 featuring key speakers and a display
- increasing membership throughout the nation, and forming branches at district level
- negotiating with the Government to declare one day each year as a Science Open Day. The day will enable institutions to organise science activities for the public
- organising science quizzes and oratory contests for various school grade levels
- publishing a science journal three times per year

Although young with limited finances, the Association is very active.

For further information write to:
Vijendra Prakash
Secretary
Fiji Association of Science Teachers
PO Box 8018
Nakasi
Fiji
PROJECT 2000+
International Forum

UNESCO Headquarters, Paris
5 - 10 July 1993

Will your Science Teacher Association be represented at this forum which will consider the way to launch the main phase for Project 2000+? Should you be present?

ICASE would like to hear from you if

• You can represent an organisation such as a Science Teacher Association which is interested in Phase 3 of the project (see article on Project 2000+ in this issue).

• You are interested in submitting a paper abstract (200 words) on one of the themes in the forum. If you have an interest, please take note of the important statement below.

• You are involved in on-going projects related to the theme of the forum. It is important that the forum is aware of all development in projects around the world which build on rather than duplicate such efforts.

The goal of Project 2000+ is improved scientific and technological literacy for all in the 21st century throughout all countries of the world.

Please note that the International Forum is not a conference in the normal sense where papers are presented. The forum is a discussion session to work on outcomes and recommendations to launch the third and most important phase of the project. The papers are needed as background material to illustrate the latest thinking for the various focus areas. As such, these papers play an extremely important role in the development of the project as a whole and only papers relevant to a focus area (as suggested by focus area leaders) will be solicited as full papers.

For further information, contact

Dr Jack Holbrook, ICASE Executive Secretary
UNESCO Science & Technology Education Unit
7 place de Fontenoy, Paris, France (Fax +33-1-40 65 94 05)

Photo right: Some of the local participants at the Eighth ICASE-Asian Symposium held in Colombo, Sri Lanka, 2-10 August 1992. This conference, organised jointly by ICASE and the Sri Lanka Association for Science and Mathematics Education, addressed the theme 'Science Education for a Changing World'. See the report in the section 'Science Education Around the World' in this issue.
Project 2000+
Revisited

by Dr Jack B Holbrook
Executive Secretary, ICASE

This article is intended as an addition to the rationale and description of Project 2000+ as featured in the June 1992 issue of Science Education International. It includes greater information on how persons can assist the Phase 1 data-gathering stage and participate in the International Forum (Phase 2) to be held in Paris, July 1993.

Project 2000+ International Forum

Project 2000+ is to be launched by seeking definitions, adopting resolutions and putting forward plans of action for the achievement of scientific and technological literacy worldwide at an international forum to be held in July 1993.

This forum differs from many conferences in that attendance is by invitation. Furthermore, participants are being asked to look forward to the way Project 2000+ should develop and the guidelines that need to be put into place, rather than to present and discuss papers. The forum is not intended as a time when researchers will inform of their work or developers will give a presentation on their curricula. Although there will be a few keynote speeches, these are designed to initiate the discussions and to put the project into perspective. There will also be room for a few paper presentations, but these will be carefully chosen by leaders of the 6 focus areas (described in the June issue) so that they are particularly supportive and relevant to the discussions and deliberations that will take place.

There will be plenty of room for papers, conference reports, etc to be distributed and read by participants before attending the forum. Some invitees, especially those recommended by a Science Teacher Association, would be expected to participate in the discussion and play a much greater role in post-forum activities launching Project 2000+ in their own country.

There will be room for displays and other presentations such as film-shows, playing of videotapes, showing of slides, computer programs, etc by all participants. This will be very much encouraged to illustrate the types of developments and projects that are actually taking place and which could have very important bearings on Project 2000+. A viewing room will be specially set aside throughout the forum for this purpose and agencies, industry, science education organisations and other bodies would be invited to supply suitable materials.

But the main focus of the forum will be to launch Project 2000+. This phase of Project 2000+ will be national programs, that is developments at a pilot or pre-pilot stage in as many countries as possible. These need to bear in mind that the year 2000 should see the implementation of relevant scientific and technological literacy curricula for at least the compulsory years of schooling.

Each country will have its own timetable, its own agenda and its own priorities and way of working, but within this, the Project 2000+ secretariat will fulfil a supportive and coordinating role. It is anticipated that in many countries use of existing ‘Education for All’ (EFA) task forces will provide the impetus for development. Other countries may see the Science Teacher Association playing an important role, or the INISTE centre, or other institutions.

But whatever pattern or patterns are chosen, the important factor that should emerge is that it is a partnership, a partnership between Government and NGOs (non-Governmental Organisations such as Science Teacher Associations).

New Address for ICASE Executive Secretary

Please note that, as from 1 January 1993, all correspondence for the ICASE Executive Secretary should be addressed to:

Dr Jack B Holbrook
ICASE Executive Secretary
Science and Technology Education Unit
UNESCO, 7 place de Fontenoy
75700 Paris, France
Involvement of NGOs (WCEFA, 1990)

Statement of principles for the involvement of NGOs in World Conference on Education For All follow-up activities with non-NGO bodies (abridged statements):

- NGOs shall be part of all formal structures for the implementation of programs at all levels: local, national, regional and international from the outset, particularly in the development and implementation of national plans.
- NGOs shall choose their own representatives within suitable guidelines
- Subsequent major meetings and conferences shall include NGOs as full delegates.

These are suggested statements of principles for project 2000+

Phase 1 of Project 2000+

The Forum is not intended as a conference in the normal sense. It is not intended as an occasion for science and technology educators to let the world know about their research and developments. That is the role of Phase 1.

Phase 1 is the gathering of previous conference outputs and developmental research and teaching materials that are geared to the attainment of scientific and technological literacy for the 21st century. Such materials are being gathered for all focus areas. Articles and reports are now being collated by Professor John Penick, ICASE Special Projects Officer (see June journal, page 2), but other materials such as project documents, videotapes, and other teaching resources are also being solicited and will be compiled by the project secretariat and the focus area leaders to provide input into the international forum.

It is difficult to give a full description of the materials that would prove useful as these are far ranging and very diverse, but as a simple working definition it is suggested that Phase 1 materials are 'materials that support the work of the forum in providing guidelines, definitions, outcomes and exemplars for national bodies to begin the task of developing and implementing scientific and technological literacy programs in the years ahead. Examples of materials related to good classroom practice, good teacher education methods and good assessment and evaluative techniques are especially relevant.

In some cases, useful Phase 1 material may be available associated with a project, especially if the project is related to indigenous technology. In other cases, the materials may be stand-ones, or material that is a collection of examples. The materials will only be useful if they relate to a student trait, that is student involvement is indicated in some way.

Wanted!
Science Activities Around the World

Examples of simple, hands-on science activities especially those with a local or regional flavour
ICASE is compiling a book of Science Activities Around the World
Make sure your activity and your name as the person submitting it is included

Send materials to John E Penick
789 VAN Allen Hall, The University of Iowa
Iowa City, IA 52242-1478, USA
Where does the material come from? One suggestion is that useful material will exist in journals, bulletins, newsletters and especially in in-service teaching notes of course tutors, or in small scale projects initiated by a teacher or group of teachers. If the science curriculum is very innovative in your country, then the current teaching will be appropriate (but this is not really anticipated as it belies the need for project 2000+).

An indication of materials that would not be useful may provide additional guidelines. It is suggested that the following are not helpful:

- Science (or biology, chemistry, physics, earth science) teaching materials that do not have a societal/technological relevance
- Experimental materials that do not have a societal/technological relevant attributes
- Assessment materials that do not measure societal/technological relevant attributes
- Factual material (unless it is supportive of student centred activities such as role playing/debating, initiating an investigation).

If you would like to submit materials, be part of the Project 2000+ forum, or simply wish to gain further information, please write now to Dr Jack Holbrook, Science and Technology Education Unit, UNESCO, 7 place de Fontenoy, 75700 Paris, France.

References

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**ICASE AWARD SCHEME**

_for outstanding contributions to international science education_

_Nominations for these awards must be forwarded by member associations of ICASE. For full details of how to forward nominations, contact the Executive Secretary below._

**ICASE Distinguished Service Award**
This award is made to individuals who have a career history of distinguished service to international science education through their involvement in the international activities of local, regional and global science education organisations

**ICASE Regional Service Award**
This award honours individuals who have made a significant contribution to international science education through their involvement in international activities at the local and regional levels

**ICASE Association Award**
This award recognises individuals who, within their science teacher association, have made a significant contribution to the international activity of their association

Contact Dr Jack Holbrook, Executive Secretary ICASE
UNESCO Science & Technology Education Unit, 7 place de Fontenoy, Paris, France
The Present and Future of Science Education in Pakistan

by William J Boone & Alyas Qadeer Tahir

Since the creation of Pakistan in 1947 there have been numerous science education curricular revisions. However, these past efforts have often been characterised by rote memorisation and the recall of facts. In an effort to make sweeping changes within science education the Pakistani Ministry of Education conducted a science education needs assessment during the years 1984-85. The results highlighted the lack of qualified science teachers, administrators and supervisors at both the school and college level. School level science was found to be often taught by those who are professionally inexperienced as well as those who are uncommitted and unmotivated toward science teaching. As a result, the quality of science education was diminished and pupils were not achieving their potential. Furthermore, the assessment suggested that no matter how high the present quality of university teaching and research in science, the system was weakened by inadequate school science teaching.

In reaction to this study, the Ministry of Education began a multi-faceted science education reform project with funding from the Asian Development Bank. When the project is fully implemented in March of 1993 it should serve as a model for other developing countries that have to confront problems of national assessment, multiple languages, often inadequate teacher training, and a lack of science supplies. In the following sections of this paper the structure of science education in Pakistan will be briefly outlined, as well as the major components of the present far reaching reform effort.

At the elementary school level (grades 1-8) science is compulsory. At this stage science is presented so a range of science topics (chemistry, physics, biology) are introduced to pupils. Commonly elementary pupils at each grade learn their science from one teacher. Therefore elementary teachers must be well versed in all of the sciences. At the secondary level (grades 9-12) the amount of science presently taken by individuals depends on whether or not pupils choose to major in the sciences or the humanities. If a science major is selected, then pupils take classes in physics, chemistry, biology and mathematics. Those pupils who select a humanities concentration are all required to take a general science class. At this level one teacher commonly instructs both chemistry and biology, whereas physics and mathematics is usually taught by a different teacher.

The Reform Effort

Many aspects of the present nationwide reform effort are noteworthy. First, the Institute for the Promotion of Science Education and Training (IPSET) has been established in Islamabad, the capital of Pakistan. Additionally, four regional science education centers have been set up in each of Pakistan's four provinces (Punjab, Sindh, North West Frontier Province, Baluchistan). In addition to the development of these centres, care is being taken to improve the science facilities at schools within each province.

Furthermore, a cadre of master science teachers have attended a four week staff development training workshop so that they may train less experienced teachers. Since science supplies are often lacking in many of the nation's schools this project included the development and distribution of over 4000 science kits for middle school level teaching. The included table lists major components of the reform effort.

Another exciting and challenging aspect of this reform is its guiding goal of fostering a concern for pupil learning through application of concepts – this is quite a change from the 'traditional' outlook toward science education practised in many developing countries. This interest in both pupil and teacher application and synthesis of science material is being used to develop new curricular materials (textbooks, pupil manual, and teachers guides) as well as a national test item bank. Pakistan's current science education reform effort should be a helpful model for other countries in that it involves a coordinated effort among teacher trainers, active instructors, kit developers, textbook authors, and psychometricians. Furthermore, the structure of the reform effort (four regional centres, one national centre) will enable the work of regional sites to be monitored and will facilitate the sharing of information among the regional headquarters.

The reform effort being implemented in Pakistan is both exciting and difficult. Not only do science educators in Pakistan have to consider the infrastructure of local schools, and the logistics of nationwide testing, but there is the considerable complication of having to accurately translate texts, manuals, guides and test items into two different languages! However, even with these hurdles to clear the work now being carried out in Pakistan represents a proud step for science education. Now science education will be led, coordinated, monitored, and supported over the long term. This should help increase the supply of scientists and technologists, and will also result in better informed citizens.

A table summarising the major components of the present science education reform project appears on the following page.

About the authors

Dr William J Boone is Assistant Professor of Education at Indiana University. He can be contacted at Education 3068, Indiana University, Bloomington, Indiana 47405, USA.

Alyas Qadeer Tahir comes from the Institute for the Promotion of Science Education and Training, Islamabad, Pakistan, and can be contacted at the School of Education, Indiana University, Bloomington, Indiana 47405, USA.
## Major Components of the Project

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Components of the present science education reform effort. Columns list the results of reform in the federal capital (Islamabad) as well as Pakistan’s four provinces – Punjab, Sind, North West Frontier Province (NWFP), Baluchistan (Bal)
Role Play
In Science Education

by Asoka Weerasinghe

Reprinted from the Proceedings of the 6th ICASE-Asian Symposium

Abstract
The paper discusses the importance of open discussions when inculcating moral and ethical values in pupils, during science lessons and recommends the use of role-play exercises as a method by which pupils could be drawn into open discussions. Advantages and disadvantages of role-play exercises, and methods of conducting role-play exercises have been included in the paper. A case study of a very interesting role-play exercise, which was conducted in a science class at a secondary school in Sri Lanka, has also been included in the paper.

Introduction
Looking back on the history of science education some important landmarks can be identified. During the initial stages the emphasis was on learning 'scientific facts'. This lead to the stage where importance was given not merely to knowing facts but also to understanding their relationships and formulation of generalisations, and theories, connected with them. The next stage was characterised by the 'investigatory approach' to science education, where in addition to the earlier trends, importance was given to methods of gathering data, and coming to conclusions. Further evolution of the development of science education was characterised by the introduction of the social importance, of what was learnt during science lessons. This could also be termed as 'Science Technology and Society Education' (Solomon 1988; Gorbman 1971). One of the most recent developments of science education can be identified as the introduction of ethical and moral implications, of that which is learnt during science lessons. The outcomes of the conference organised by ICSU on 'Science Technology and Future Human Needs', held in Bangalore in India during 1985, may have influenced this particular twist in the evolutionary process of science education.

The following were included amongst the important aims of the conference:
- to stimulate an awareness of ethical and social dimensions in science education
- to present selected problems: intrinsic, ie linked with science itself, and extrinsic, ie linked with its role in development
- to provide information on the efforts being made to deal with ethical and social problems in the practice of science education (Frazer and Kornhauser, 1986)

Each of these evolutionary trends were characterised by the introduction of different teaching and learning strategies. The earliest teaching strategies included, mainly the imposition of knowledge by the teacher, by the lecture method. Here the teacher played the dominant role in science lessons. As newer science education programs developed, the emphasis shifted more towards pupil centred activities, such as science project work which required investigatory work by the pupils.

Inculcating ethical and moral values during science lessons
Creating an awareness of the moral and ethical implications of that which is learnt in the science classroom, in the pupils is a difficult task. This cannot be done by mere imposition of knowledge by lecturing, as this will tend to indoctrinate the pupil. Developing ethical and moral values involve developing in the pupils, a value system which deals with what is good and what is bad, and also with what to do and what not to do. Such a value system cannot be built by the use of classroom activities traditionally used by science educators, as most of those methods may tend to indoctrinate the pupil. Desirable value systems are built, when there is no indoctrination, and when the individual builds that system intrinsically through one's own personal development. Development of value systems in a person takes place gradually, along with one's physical, mental and intellectual development. It is therefore important to help pupils to develop and work out their own value systems according to their level of mental and intellectual development. One important strategy to develop value systems in the pupils is by open discussion with teachers and peers (Furth 1979).

Open discussions and Sri Lankan culture
In a country like Sri Lanka open discussions between pupils and teachers may pose a problem. Firstly, learning strategies seem to be mainly geared towards memorisation of facts. This is not only because of the strong emphasis, and the back-wash effects of written examinations in the country, which tend to assess mainly cognitive knowledge (Dore 1976; Lewin 1984), but also traditionally a learned person in the Sri Lankan culture is considered to be a person who can commit to memory a large amount of knowledge. For example, a learned Buddhist monk, during the time of Sinhala Kings (ie before 16th century), was considered to be a person who could recite the Tipitaka, (an important Buddhist text) by memory. Secondly, the teacher of the 'Guru' in the Sri Lankan culture is held in very high esteem not only by the pupils but also by the society, as a fountain of knowledge. Under these circumstances, pupils may feel
reluctant to challenge, question, argue and discuss what has been taught by their teachers, and enter into open discussion with them.

**Introduction to role-play exercise**

An effective way of making pupils participate in open discussion is by introducing role-play exercises, where pupils are asked to act particular roles and react to simulated situations (Frazer 1986). The Dictionary of Education, explains, role playing as '... an instructional technique involving a spontaneous portrayal (or acting out) of a situation, condition or a circumstance, by a selected number of a learning group'. As Taylor & Worford (1978) pointed out '... all that is required of role playing is for the participant to accept a new identity, step inside someone else's shoes and act and react appropriately'.

Role-play has a subtle appeal to the emotions. It is similar in many ways to rhetoric discourse. Therefore role-play exercises share with the rhetoric the ability to sway opinions, and influence judgements, which are important in moral and ethical development of a person. Straight-forward debate or pedagogy may not be sufficient in this development.

Role-play was initially an exclusive claim of drama teachers, and it was later extended to subjects like languages and social studies. It has been found that role-play comes easily into learning situations, and it is in fact as natural as breathing. This is perhaps why social workers, counsellors, personal managers, have been seen to use it extensively. The utility of role-play as a learning method is undeniable and much is to be said for making role-play a technique available to teachers in all subjects as a valuable educational resource. Role-play has only just begun to infiltrate the science classroom, and this was almost unknown to science classes in the past (Solomon 1988). In the Sri Lankan situation role-play does not tend to destroy the traditional teacher-pupil (Gola-Gola) relationship. Even if the pupil behaves in a traditionally unacceptable manner, questioning and arguing with the teacher will be acceptable because the pupils and the teacher know that pupils are only play acting.

**Advantages of role-play exercises**

As stated by Jones (1979), there are many other advantages of role play exercises. The following list of advantages of role play have been compiled with reference to Jones, and the experiences of the author of this paper.

- Role playing helps pupils to express feelings and attitudes and to discuss them, thereby changing their attitudes where necessary, and helping in the maturation of their personalities.
- The pupils are encouraged to feel a situation rather than intellectualise about it.
- Role playing is a safe substitute for some real life situations. Sometimes real life experiences can be hard and bitter; mistakes that happen in real life may leave painful scars. During role-play, mistakes that one makes do not matter, and they do not leave bitter scars. Yet one can learn from them.
- Role play stimulates creativity, and critical thinking.
- Role play helps to develop social skills in that it makes one choose carefully words, gesture and approach.
- Role play helps as a powerful motivating factor for pupils to study.
- Role play helps the teacher to make a comprehensive evaluation of the pupils, in the cognitive, psychomotor and affective domains. For example the knowledge gained by the pupils in connection with a particular role will help the teacher to assess the cognitive abilities of the pupils. Their skills and abilities to debate can also be assessed, while their attitudes can be observed, as they react according to their roles during the role play exercise.
- Role play helps pupils organise thoughts and responses instantly, while reacting to the situation in question.
- Role play helps pupils remain calm in the face of adversity or pressure.

**The disadvantages of role-play exercises**

- What happens during a role-play is anybody's guess. It may however be possible to bring greater structure into the exercise by using pre-determined objectives.
- Pupils sometimes over emphasise or under emphasise particular roles and take the lesson along unintended paths.
- Pupils with talent may monopolise the situation.
- Pupils may be carried away in their roles and this may lead to disruption of the class, or become a distraction to the learning situation.
- Shy pupils or pupils with speech problems may not like to learn this way.
- Role play may be beneficial only to the persons actually participating, unless attempts are made to draw the whole class into it.

**Methods of conducting role-play exercises**

Role play can be structured or unstructured, the latter is something that would occur spontaneously during a lesson. For example during a science class on nutrition, the discussion steered towards a prominent television advertisement which highlighted the value of a brand of imported powdered milk. Some pupils wished to know whether fresh milk, or locally manufactured powdered milk was inferior. The teacher asked two pupils to take roles as a salesman of foreign milk powder, and as a salesman of local milk powder, and present their cases to the class. The arguments presented by them were helpful to the pupils in the class in providing opportunity for deeper consideration of the issue and equipping them to come to a conclusion of their own.

Structured role play exercises need more planning. The roles should be carefully worked out. The situation has to be carefully planned. Preferably the teacher should put all these details on paper. Roles should be allocated well in advance so that pupils can study their roles, collect relevant facts and plan what they should say during the role play exercise. The teacher may even coach the pupils separately. It may also be helpful in certain instances to get all the participants together and discuss their roles. Non speaking roles also may be given to the pupils in an effort to draw in more pupils to participate. Technical aspects such as tape recording the
proceedings can also be given to the pupils. See figure 2 for a flow chart which shows the details regarding arrangements of a structured role play exercise.

Identification of a suitable issue or a topic to be discussed during the role play exercise

- Plan the situation where the issue or the topic would be discussed. Define the roles for the exercise. The talent available, and the needs of the issue should be kept in mind.
- Call for volunteers for the roles.
- Allocate the roles to the volunteers. Try to match roles with their characteristics.
- Discuss with all the volunteers details regarding the issue or the topic.
- Give time to the participants to study their roles and gather information regarding their roles.
- Find strategies to involve other pupils in the role play exercise eg newspaper reporters.
- Make arrangements to tape record the exercise.
- Conduct the role play.

- Discuss the learning outcomes of the exercise with the whole class.
- Arrange re-enactment of roles where necessary.
- Plan suitable written work for the pupils.
- Make arrangements for the pupils to listen to the tape recording of the exercise.

Post role play activities

Role play activities do not end with the actual classroom enactment of roles by the pupils. It is equally important to analyse what happened during the role play exercise and determine what should be learnt. This can be done by further discussions and if necessary by re-enacting useful and important parts of the role play exercise. Listening to the tape recording of the proceedings of the role-play exercise will also be invaluable post role-play activity. The recording will not only help to further reinforce what was discussed, but it can capture useful and provocative experiences which will be a stimulant for role playing sessions on a later occasion (Pirrie and Dalgell-Ward, 1962). Refer to Figure 1 for a case study of a role play exercise, which was conducted in a Sri Lankan science class.

Figure 1

Case study of a structured role play exercise conducted in a Sri Lankan science class at secondary school level

A very interesting role play exercise was conducted by the teacher and pupils in a Sri Lankan secondary school science class. The issue to be discussed was the fate of an urban nature reserve situated very close to the school. Should this reserve be conserved or should it be used for other purposes? The school (Trinity College) is situated in Kandy. At the beginning of this century the area was about 400 hectares but it was now reduced to 100 hectares due to people forcibly acquiring the land from time to time for housing and agriculture.

The individuals taking part in the discussion, supposedly held at the Town Hall of Kandy, included persons from different interest groups with differing ideas regarding the reserve’s future. Those taking part in the role play took on pseudo names in keeping with their roles. Some of the names were funny, making the exercise more enjoyable to all. Figure 1 includes the list of characters in the exercise, their designations, and the main thrust of their arguments. It also shows some of the interactions that took place during the role play.

The rest of the class took part in the exercise as media people, representing the press, radio and television. Some pupils helped in the technical aspects, such as tape recording.

Each of the participants was requested to write a report on the arguments presented by them for the role play exercise, while the others were requested to write reports for their newspaper, journal, radio or television.

An interesting feature of this exercise was that it was an excellent example of making pupils aware of moral and ethical issues involved in conservation. The issue being linked with science itself, dealt with extrinsic issues such as development, leisure and even meditation. Therefore role play exercise was in keeping with the aims of the Bangalore conference.

Another interesting feature is that the issue discussed was a real one. Pupils may have been already aware of these issues, as various aspects of this issue were discussed by the press, radio and television. While role playing exercises can be made up, they are more powerful if real life situations are used.
Figure 2

The manner in which participants in the role play exercise interacted with each other.
Figure 3
Flow chart indicating various stages in organising a role-play exercise

Identification of a suitable issue or topic to be discussed during the role play exercise
Plan the situation where the issue or topic would be discussed
Define the roles for the exercise, keeping in mind the talent available and the needs of the issue
Call for volunteers for the roles
Allocate the roles to the volunteers, trying to match roles with their characteristics
Discuss with all the volunteers, details regarding the issue or the topic
Discuss details regarding each role separately with the participants
Give time to the participants to study their roles and gather information regarding their roles
Find strategies to involve other pupils in the role play exercise, e.g. newspaper reporters
Rearrange the furniture of the class to suit the situation, e.g. courtroom
Make arrangements to tape record the exercise
Conduct the role play exercise
Discuss the learning outcomes of the exercise with the whole class
Arrange re-enactment of roles where necessary
Make arrangements for the pupils to listen to the tape recording of the exercise
Plan out suitable written work for the pupils

Conclusion
Role play is a powerful educational force, and skilfully used it can provide groups of all ages, in any subject area, insights, laborious or even impossible to achieve by other means.

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About the author
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Reflections of Russia

by Gerald H Krockover

Adapted from the ICASE Luncheon Address
NSTA National Convention, Boston USA, March 1992

I am celebrating my 28th year in the field of science education and during those years I have had the opportunity to travel to numerous countries around the globe. But none of those trips was more exciting than the opportunity I had during the summer of 1991 to visit the former soviet union with 350 educators from American, Canada and Britain as part of a National Science Teachers Association sponsored trip.

As we prepared for the trip there was a great deal of excitement along with anxiety regarding what we might encounter and what might happen to us during our ten day visit. The excitement peaked when many of us gathered at Kennedy International airport in New York prior to flight across the Atlantic. We discussed our hopes and aspirations for a positive interaction and we talked about the presentations we would each be making during our visit to Moscow State University.

Upon arriving at the airport in Moscow it was quite evident to us that we were entering another era and that we were beginning a vastly different educational experience. The greetings from our student and faculty hosts were enthusiastic to the least. It became evident to me that our visit was going to be extremely successful and most enjoyable. Interaction between educators from both countries began almost immediately and friendships emerged as dialogue on education began and we shared our hopes for the future.

My session was scheduled for one of the afternoon periods. I am not usually very nervous with respect to making presentations since I have made literally hundreds of them. However, as I approached my presentation room I was becoming quite nervous. Would the teachers like what I had to say? Would they be able to understand my terminology? And, would they ask questions? As I entered the room I noticed that it was full and I began to get really nervous. The room was approximately 80% full with Russian educators. There was a slight problem - there was no translator for the session!

One of the American teachers I have worked with over the past five years volunteered to go out into the hallway and find a translator. She located a research chemist from Siberia who spoke excellent English and who volunteered to become my translator. She has since become a close friend.

Our session was lively; the Russian educators enjoyed it immensely and asked lots of questions. As I participated in other sessions, I found the same reception regardless of whether it was a Russian or a US presenter. As the days progressed, the dialogue became more focused with discussion about educational opportunities and the need for a continuing dialogue.

As an outgrowth of these experiences, I would like to recommend an article in the November/December 1991 Journal of Teacher Education entitled 'World Wide Issues and Problems in Teacher Education' by Howard B Leavitt, Director of the Council on Global Perspectives for the Professions, Amherst, Massachusetts. The article which is from his new book Issues and Problems in Teacher Education: An International Handbook, deals with many of the topics that we discussed with our Russian colleagues, and clearly delineates the specific problems relating to Russian education. These include:

- The recruitment of the most promising teaching talent and the competitiveness that exists from other more lucrative and more prestigious professions
- The content of teacher education - the discussion centred around the tensions that exist between the university ideal of knowledge for the sake of pure scholarship and the public school's interest in knowledge for practical purposes.
- Governance and quality control. This area can be summarised with the question, 'To what extent should the jurisdiction of teacher education and quality control be the province of central government as opposed to state or local administrations? ' When teacher education is perceived to be weak, when criticisms of teacher education institutions are publicised, and when economic recessions diminish funding for teacher education, public pressure is likely to build for state or national governments to intercede. Such interventions tended to diminish the authority for institutions for teacher education by imposing specific curriculum and certification requirements.
- Research was also discussed extensively with our Russian counterparts. Again a question best summarises discussion: 'To what extent should basic research be undertaken in contrast to research that can be immediately applied to the development of a program policy?' There appears to be a growing consensus world-wide that research and teacher education should become more action oriented and address policy issues related to improving the quality of programs at greater cost effectiveness.

- Professionalism. In many countries around the world teaching is treated as a semi-profession due to, among other things, the lack of a strong knowledge base, teachers' limited autonomy to make professional decisions, and accountability to superiors rather than to the profession.
- The notion of what is a teacher educator? This can best be highlighted by the question, 'To what extent should the activities of teacher educators reflect their connection with higher education traditions of research and scholarship rather than the responsibilities for preparing teachers to teach and
inducting them into the profession?'

• In-service education. This seems to be a problem world-wide because of the difficulty in coordinating pre-service and in-service education as well as providing coherence to countless problems of different types, organising efforts which take place by countless institutions, and a variety of goals that seem to be constantly moving. This problem tends to be magnified when a financial crisis exists. As a result, the world picture of in-service education is that of a huge variety of programs with on-again, off-again quality that trivialises both the concept of life-long learning for teachers and the process of induction into the teaching profession.

It appears that three major issues related to teacher education and to education in general, will have to be faced with respect to the restructuring of the Commonwealth of Independent States of the former Soviet Union. This includes the fact that teacher preparation takes place in three distinctly different institutions: secondary school institutions, pedagogical institutions, and universities. The major differences in the degree to which these institutions instil professional commitment and the ability to teach make it difficult to initiate nationwide reforms in such a fragmented system.

The second issue deals with attempts to liberalise a formalistic teacher training plan where the balance between academic courses and pedagogy is overwhelmingly tilted towards the former, especially in universities.

The third issue that will have to be dealt with concerns the neglect of financial support of education and the welfare of teachers. Low salaries, poor benefits and difficult working conditions, and buildings, equipment and curriculum materials which are deficient by any international standard, have produced a crisis in education. A severe shortage of competent teachers with a long-term commitment to teaching also exists.

Distracted by other more pressing aspects of reform, the governments of the former Soviet Union have only recently begun to grasp the enormity of the problems of producing an educated citizenry capable of achieving the commonwealth's new goals.

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**Project 2000+**

**Scientific and Technological Literacy for All**

Calling all science teacher associations around the world

Are you aware of Project 2000+, an initiative of ICASE and UNESCO?

ICASE is now calling on all science teacher associations around the world to begin planning to unite with national institutes, science centres and other appropriate bodies to promote Phase 3 of this project.

Phase 3 is the major part of the project and will begin in earnest following the Phase 2 International Forum to be held in Paris, July 1993. Phase 3 consists of projects initiated and carried out in a country. They may be national in scope, or smaller regional projects.

Their purpose is to enhance scientific and technological literacy for all.

National task force groups may be set up to initiate cooperative developments among a number of interested partners. Governments may be involved – UNESCO will certainly be encouraging this. Regardless of whether there is any other support, ICASE will be behind the association offering whatever help it can.

But we have heard all this before!

An important aspect of Project 2000+ for better science and technology education is that far greater stress will be placed on IMPLEMENTATION and EVALUATION factors. These require teacher involvement – hence the importance of science teacher associations to be enthusiastic about Project 2000+.

Research has shown that current practices have been putting much emphasis on creating and developing intended curriculum, but that what is actually implemented is a far different picture. Much intending curricula advocate student-centred classrooms, highly trained and enthusiastic teachers, enlightened and varied teaching approaches and extensive feedback taking place in the classroom.

Reality shows teacher-centred, expository approaches that can, in many instances, hardly be called ‘teaching’.

If there is a way to change this, then the secret lies with the teachers. Implementational change is in the hands of teachers. Getting teacher support for implementational change is crucial. No support, no change! No science teacher involvement, no ICASE involvement!

ICASE stands for the creation of better curricula that promote scientific and technological literacy, the development of values, and the development of scientific and technological skills – and not merely the assimilation of a depth of factual information. ICASE supports the outcomes of the Bangalore conference (held in Bangalore, India in 1985) and its thematic approach. ICASE supports STS teaching and its incorporation of values. ICASE supports constructivism and research into the manner in which children learn science.

Project 2000+ is to effect these changes at a national level. The project secretariat is being set up now. It is waiting for your call... let ICASE help you with your Phase 3 project.

Contact Dr Jack Holbrook, Science & Technology Education Unit, UNESCO, 7 place de Fontenoy, 75700 Paris, France

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**INCOTE 92**

**International Conference on Technology Education**

Weimar, Germany

25-30 April 1992

by Dr J Holbrook

This conference was organised by Professor D Bladow, Pedagogische Hochschule Erfurt and Technische Universiteit Eindhoven, with the help of a number of international and European organisations.

A notable outcome of this conference was the creation of WOCATE (World Council of Associations for Technology Education), an umbrella organisation designed to link technology education associations around the world. Kevin Morgan (Australia) was elected as the first chairman with Professor Bladow as secretary. It was agreed that the secretariat would be based at Erfurt, Germany.

The conference drew attention to the very wide interpretation being placed on technology education around the world. In many third world countries there is little difference between technology and technical education, and both are related to the promotion of indigenous technology as a craft related exercise. Technology is seen as an end product and the skills are design and construction related.

In other countries, technology education is closely aligned with design, and is a problem solving process course where home technology and computer technology are integrated with areas geared to the utilisation of materials such as wood, metals and...
plastics.

It was striking to note the strong expressions dissociating technology education from science education. Whilst many speakers drew attention to the cross curricula nature of technology education and the links with economics, language studies and even history, links with science were quickly dismissed and, instead, differences dwelt on. Such differences were hard to reconcile without taking a very 'pure' approach to the teaching of science subjects.

Areas covered by papers on the themes of the conference were:

Strategy transfer – the interchange of experiences of technology education between eastern and western countries

1. Technological competencies, curriculum frameworks and teaching methods

In the area of stages of transfer, papers were presented on idea generation, identification, evaluation and assessment; communication; and a transfer strategy for conferences.

In the area of competencies and curriculum frameworks, papers were presented on the interdisciplinary nature of technology education and the links with science and other subjects; the situation of process skills not being clearly understood; the need for attention on design, development and implementation of technology education; and the need for an agreed philosophy.

In relation to primary school approaches, papers were presented on the philosophy behind technology education at this level; theoretical models; methodologies; and the need for a separate section on this area at the next conference.

Papers were presented on views and effects on high schools, focusing on topics such as: the necessity for a program for all youth to build confidence to learn from/with technology; and the need to define the scope to consider the inclusion of areas such as environment, or employment and livelihood.

In summary, there is a need for more dialogue and research; environmentally astute technology education courses; and the relating of technology education to culture and economic realities.

2. Technology teacher education

Papers were presented on philosophy, content, structure, pedagogy, quality, cooperation, breadth/flexibility, and research. The papers suggested the need to strengthen the societal interface, future planning, networks, and the politics of change.

3. Assessment and testing of technological competencies

Papers were presented on the topics: what to assess; capability in the process of task identification; recognition of importance of values and attitudes; ability to identify, seek out and apply knowledge and skills; the analysis of process in several ways; and the need to assess whole rounded performances in view of the learning process being more than the sum of its parts.

4. Technology education. advanced technology, industry links and the interface with environmental understanding

Papers were presented on: emphases on environmental issues; technological progress and science, social or child orientations; social orientation and an emphasis on discovery learning; and the trend to use problem solving as the starting point for socially oriented programs.

Technology, creativity and innovation

1. Role of technology education in developing human resources

Papers reflected the following viewpoints: all need technological literacy; the need for a skilled workforce not only in terms of technological capability, but also in terms of affective skills and values; technological capability in terms of flexibility, multidisciplinary creativity, team spirit and foresight.

2. The methodology of technology

Papers reflect the following: a general lack of insight into methodology; the need for methodology to be determined by particular groups of students and by teaching/learning aims; new technologies promoting new methodologies; awareness of available tools; the need for methodologies to be relevant; and the management of the physical environment.

3. Evolution of the nature of the human-technological interface

Papers reflect the following: the dynamic relationship of the human-technology interface; the greater sophistication of relationships as technology depends less on natural resources and unskilled labour, and more on human capability; the synergistic relationship impacting both positively and negatively on technology and individuals; the growing concern about the negative, indiscriminate use of technology; the need to account for local customs when transplanting technology; the need for educators to teach technology uses without compromising the need to be future oriented; the need for proactive approaches to technology change and the consideration of ethics in technology education strategies.

4. Human creativity, interests and technology activity and the means of overcoming barriers to technological thinking

A technology learning environment is one where the perceived realities interface with the external world and the internal landscape of the student. Barriers to this are the over challenges of the external world and the internal landscape. Also the under challenges of the external world and internal landscape pose a problem if activities are not challenging. Ways of overcoming barriers include: integration of technology, creativity and tools imagination; development of hardware/software for the external world and for the internal world.

Philosophy of technology

Papers were presented on: clarification of key philosophical terminology; identification of useful conceptual frameworks; evolving philosophical trends; uniqueness and commonalities among countries; differences between science and technology; and the uniqueness of technology knowledge.
Summary

This conference showed that the current trend in the developed world is towards the creation of a subject called technology in which problem solving skills are paramount. The subject is easily linked with design, and widened to incorporate areas such as home economics and informatics. It concentrates on solving real life concerns by practical means. As such, it lacks a theoretical base and has not yet penetrated into the less developed countries. When it does, I see the dilemma being whether it should be separate from or combined with a reconsidered science education program. The latter may be very attractive in terms of relevance, promoting indigenous technologies, and needing less specialised and costly facilities.

An Invitation to Kansas City
NSTA National Convention
March 1993

International Round Table

Each year at the NSTA National Convention, the International Committee of the United States National Science Teachers Association (NSTA) hosts an International Round Table. At this 90 minute session, presenters from different parts of the world discuss their country's science education programs.

Each presenter is provided with a table for a materials display. Those attending the International Round Table session visit the tables of countries they wish to learn about.

If you would like an official invitation to participate as a representative of your country, write to:

John E Penick  
Science Education Centre  
Room 789 VAN  
The University of Iowa  
Iowa City, IA 52242-1478  
USA

Participants will be required to arrange their own funding. The letter of invitation, and your name listed in the program, may help you as you seek funding support.

For information about other conferences refer to the Calendar section in this issue.
Eighth ICASE Asian Symposium
Sri Lanka
2 - 6 August 1992
Report by Dr J Holbrook

The 8th ICASE Asian Symposium was jointly sponsored by ICASE, SLASME, NIE and the Sri Lankan Ministry of Education and Higher Education.

The symposium's main theme was Science Education for a Changing World. Sub-themes were (1) high technology; (2) appropriate technology; (3) environment; (4) scientific literacy.

SLASME hosted the 8th ICASE-Asian Symposium at the National Institute of Education (NIE) in Colombo. There were about 100 participants from Sri Lanka and other Asian/Australasian countries. The subthemes were introduced by the main speakers and other papers were presented on the theme of the symposium. Discussion sessions covered the manner in which science education can contribute to a changing world. The proceedings of this symposium will be published.

SLASME is to be congratulated in hosting this symposium and showing what is possible with a small band of enthusiastic members. Although a small association, SLASME managed a very friendly and interesting meeting, and the overseas participants were well looked after. This meeting between overseas science educators and local science teachers was of particular significance. Thanks go to UNESCO and AIDAB for financial support. The British Council for supporting two of the main speakers, and to the Sri Lankan sources of financial aid, especially the Ministry of Education.

Summary of Recommendations of the Group Discussions of the 8th ICASE Asian Symposium

By Prof V K Samaranayake, SLASME

Four discussion groups met separately and made recommendations that were later approved at a plenary meeting. The recommendations are summarised as follows.

Group 1 – Environmental education
The aims should include the development of perspectives on environment based on a variety of considerations including aesthetic, biological, geographical, and physical; and the development of action to solve environmental problems including those for improvement and protection of the environment. The strategies should include the use of regional resource centres and the making of changes in curriculum and examinations.

Group 2 – Science and mathematics education
The group made a large number of recommendations which they placed under five headings:

- Inservice training programs should be re-organised.
- Assessment procedures must be reconsidered.
- Active learning by pupils should be encouraged by means of activities such as games, projects and roleplay.
- Parental involvement should be increased.
- Pre-school experiences in science and mathematics learning should be encouraged.

Group 3 – Science and mathematics literacy

- Innovative questions should be used in examinations.
- Dissemination of information relating to projects by students and

Photo (above): Professor Wynne Harlen from the UK addressing the 8th ICASE-Asian Symposium. About 100 local and overseas participants joined this successful symposium held in Colombo, Sri Lanka, 2-6 August 1992.
teachers.
• Developments of contacts between journalists and teachers.
• Schools should hold science days on which the community can visit the school and learn from the exhibits, plays, talks, etc.

Group 4 – Technology
The group identified seven priority topics and selected three of them for detailed discussion including the preparation of estimates for setting up working projects to achieve the proposals. The three projects were:
• National newsletter on science and technology education
• Making technological models and using traditional toys and games in primary schools
• Traditional technology: case studies of appropriate and environment-friendly technology

Report
The 8th ICASE Asian Symposium was organised by the Sri Lankan Association for Science and Mathematics Education (SLASME). Three other events were also held in conjunction with this symposium:
• Pre-symposium workshop on primary science
• Annual session of SLASME
• Roundtable on environmental education
All four events were co-sponsored by the National Institute of Education, Sri Lanka, which was also the venue for the events. The events were organised by special subcommittees of SLASME, enlisting the support of others drawn from the NIE, the Ministry of Education, the Ministry of Foreign Affairs, and the Ceylon Tourist Board.

The events were financed by UNESCO Paris, UNESCO Bangkok, the Australian International Development Assistance Bureau (AIDAB), the NORAD program of the Ministry of Environment & Parliamentary Affairs, the Natural Resources Energy and Science Authority of Sri Lanka (NARESA) and the Institute of Computer Technology of the University of Colombo. Local costs were met by SLASME.

Participants
Foreign participants came from Australia, China, England, Hong Kong, Iran, India, Malaysia, Maldives, Philippines, Thailand and USA.

Program
Papers were presented on the following themes:
• Environmental education
• Science and mathematics education
• Science and mathematics literacy
• Technology

Careful analysis and detailed discussion culminated in the following recommendations:

For the formal system of education
• to provide opportunities to acquire knowledge, values, attitudes, commitment and skills needed to improve and protect the environment.
• to encourage pupils to examine and interpret the environment from a variety of perspectives such as physical, geographical, biological and aesthetic.
• to arouse pupils’ awareness and curiosity about the environment and encourage active participation in solving environmental problems.
• to encourage teachers to use a variety of teaching strategies with material supplied through education authorities.
• to include problem solving, practical work, investigations, consolidation, exposition, discussion and display in the teaching strategies and change the assessment procedure to emphasise the same.
• to include innovative problems/questions demanding innovative answers in the national examinations.
• to undertake studies with the
The collaboration of the National Institute of Education, and the Department of Examinations on framing questions of the above type.

• to re-organise the in-service training program at all levels in the education system to achieve its goals.

For the non-formal system

• to involve parents through the School Development Societies to examine closely the educational activities of the pupils.

• to publish a series of booklets to disseminate information on out-of-school activities of pupils and teachers.

• to strengthen the contact between science teachers and media personnel.

Achievements

These include the motivation and stimulation of local teachers by exposing them to the work being done by others in the field of education in science and mathematics elsewhere in the world.

The presentations at the primary science workshop involved hands-on experiences of primary science for teachers who did not have a science background. If follow-up work is done on this by the National Institute of Education and SLASME, this could give the impetus to enhance science education at this level by leaps and bounds.

By setting apart one evening for CASTME, SLASME was able to give recognition and publicity to Sri Lankan CASTME award winners.

They made short presentations of their award winning works at the ICASE Symposium. By this exercise it is hoped that more teachers have been inspired to indulge in innovative work that will lead to improvements in the teaching learning situation in Sri Lanka.

SLASME has been able to harness the fullest cooperation of a number of government organisations, such as the Ministry of Education, the National Institute of Education, the Institute of Computer Technology of the University of Colombo and even the Ministry of Foreign Affairs and the Ceylon Tourist Board which do not normally become involved with the formal system of education.

For further information

Contact Prof V K Samaranayake, President, SLASME, c/o Institute of Computer Technology, University of Colombo, Po Box 1490, Colombo, Sri Lanka

33rd Annual Conference of STAN
Science Teachers Association of Nigeria
17 - 22 August 1992

33rd Annual Conference of STAN
Enugu, Nigeria
17-22 August 1992

The theme of this year’s conference was Conductive Classroom Environment for Science, Technology and Mathematics Education.

The Conference was declared open by the Executive Governor of Enugu State, His Excellency Dr Okwesili Eze Nwodo. The STAN President, Dr U M O Ivovi, FSTAN focused on the ‘Crisis in our Classrooms’ in his address and urged studies of effective classroom practices for the teaching of science.

Highlights of the conference were:
• the award of Fellowships of STAN to six distinguished members of STAN;
• the Master Project Award;
• Formation of a Science Technology and Society Panel of STAN; and
• the presentation of the ICASE Distinguished Service Award to Professor Samuel Tunde Bajah, FSTAN. This was in recognition of his career of distinguished service to international science education. Sam becomes the first person from Africa to be awarded the ICASE Distinguished Service Award, and joins an exclusive band of 9 recipients of this prestigious award.

Photo (left): STAN President, Professor Ivowi in national dress at the STAN Meeting in Enugu, Nigeria
Seminar on Curriculum Development for Secondary School Chemistry in P R China

by Dr J Holbrook

From 19th - 28th July, I conducted a seminar on behalf of UNESCO in Kunming, China for a group of 15 curriculum researchers, university professors and members of the People's Education Press. This proved to be a very interesting undertaking and I ended up doing much more and even teaching a summer school class in Yunnan Normal University on the virtues of problem solving and decision making activities. It was surprising how quickly 2 hours passes when everything that was said needed translating, and the overhead projector was not functioning as well as one would like. I very much enjoyed the experience.

The seminar itself focused on trends in chemical education and inevitably covered the need for more relevant curricula, science technology society developments, and the development of chemistry curricula. Also considered were teacher education needs and the issue of examinations, which teachers face in all countries where competition to enter tertiary institutions is great. I was able to illustrate alternative ways of sequencing the curriculum, particularly when it is accepted that a fundamental first chemistry approach is not particularly necessary and does not provide any more of a logical sequence for students than approaches which take on a more societal slant.

Much of the topics covered had a direct bearing on the thrust of Project 2000+ and it was encouraging to see the interest expressed in this project by the participants. It seems that Project 2000+ is coming at a very appropriate time for China as a new curriculum for 3rd year (grade 9) middle school chemistry begins in 1995, and developments in chemistry curricula for grades 10 upwards will begin shortly.

The seminar covered five main topics – trends in chemistry teaching; the STS movement; development of curriculum guides and textbooks; activities appropriate for new trends in chemistry teaching; and, finally, a look at assessment. The last topic was specifically included as the participants voiced this as a very strong deterrent for the introduction of more socially and technologically relevant teaching. The examination is seen as a major hindrance to the widening of skills taught in the classroom such as problem solving and decision making. Nevertheless, the inclusion of socially worded structured questions and the inclusion of relevance of chemistry to daily life was seen to be appropriate and fairly straight forward to incorporate. The concern came much more with suggestions of internal assessment, particularly with respect to the large class sizes experienced in China. This is an area for more research but the experiences in assessing large classes in experimental skills by internal assessment in Hong Kong were given to show the feasibility of such developments. The ideas on assessment did not stop there, however, as a brief look at criterion referenced assessment in a socially relevant area such as food additives was included to stress the idea of assessing from a 'can do' perspective rather than taking the more negative, penalising approach usually associated with norm referenced testing.

While looking at the range of activities, the Chinese participants became very involved with a role playing session on action to take in an electroplating factory where there had been a serious accident. This proved to be a highlight of the whole seminar.
A look at two minority families and their beliefs about who can become a scientist

by James E Nesbitt

Introduction
The implicit, as well as the explicit, interactions that take place between a parent and child constitute some type of an educational experience for the child. According to Olmstead (1991), parents are teachers everyday they interact with a child. This parent-as-teacher role begins at birth. The messages that parents convey to their children about educational issues are lessons that sometimes serve to discourage, rather than encourage a child. These messages may be influenced by a parent’s own educational experiences or by a parent’s ‘perceived’ sense of hopelessness. Within the minority community, some parents devalue education because education did not provide them with social and economic mobility. These disadvantaged parents may not be an advocate for education, while other minority parents in similar circumstances, may place an even greater value on education. How is it that minority parents from similar socio-economic backgrounds share contrary beliefs about the value of education for their lives and the lives of their children?

The historical context
The factors that influence the way some minorities perceive themselves have a historical foundation. Historically, these social conditions include: discrimination, poverty, lack of educational opportunities, and the struggle for civil rights (Looney, 1988). These factors still play a significant role in the development and the individual’s perception of self or one’s identity.

According to Looney (1988), identity deals specifically with an individual’s awareness, values, attitudes, and beliefs about oneself. Identity can also be described as a way of living – a way of viewing the world and interacting with the environment (Looney, 1988). Individuals who develop a positive identity, although confronted by these historically-rooted conditions, have established a philosophy about self that transcends the boundaries of these controlling factors. These individuals possess a positive self-concept. A self-concept that is supported by a world view or belief that the locus of control of one’s life exists within the individual. These are the individuals who encourage, rather than discourage their children, even when their educational experiences have not led to social and economic mobility.

Philosophical context
The 'constructivist' model offers a perspective or a way of understanding how individuals make sense of their world. Research findings resulting from this perspective have profound implications for the way in which science instruction is carried out (Saunders, 1992).

This model states that knowledge is socially-constructed. The meanings that individuals construct from events and experiences in their lives are understood within a socio-cultural context (Stewart and Mickunas, 1974). The interpretations of these experiences are processed through a cultural filter. The prior knowledge, values and beliefs of individuals have been shaped by their experiences. Since experiences are products of the human mind, they are by nature subjective. This subjective world is the basic context of human action (Stewart and Mickunas, 1974). This subjective world forms our worldview. This worldview is shaped by many cultural factors.

The constructivist model provides a theoretical framework for describing and interpreting data from a contextual or cultural perspective. As stated earlier, this model has implications for how we teach science and also for how students and parents make decisions about educational issues.

This approach offers students an educational experience more closely related to their reality. If students and parents experience science in a meaningful way, then hopefully the value of science in their lives will increase and as a result, their perceptions of 'Who can become a scientist?' will reflect a global view.

Beliefs about 'Who can become a scientist'

During my second year doctoral seminar, I interviewed two 8th grade minority students from my 1989-90 inner city science class. The mothers of these two young men were also interviewed. The purpose of this project was to assess the beliefs of these individuals regarding the question 'Who can become a scientist?'. Beliefs held by students will influence the role of science in their lives. Beliefs communicated by parents are factors that help give meaning to the student’s beliefs. The interviews revealed that these two families held opposing views on the issue of 'Who can
become a Scientist?”. One parent and child revealed a sense of powerlessness, while the other parent and child felt some measure of control over their lives in relationship to this issue.

Discussion

During the interview, one inner-city mother revealed examples of a negative attitude when she was asked her beliefs about ‘Who can become a scientist’. This mother held discouraging views about the possibility of her son, or for that matter any minority child from her community, becoming a scientist. She felt that some minority children don’t have the intellect or might even find science boring (Nesbitt, 1990).

In further conversation, this same mother revealed that science was not one of her strong points when she was in school. She stated that she does not want to present science as an easy endeavour, in case her son decided to go into science and couldn’t make it. Finally, she stated that as a minority parent she realised there are limits to what her son can do (Nesbitt, 1990).

The second mother held favourable attitudes toward science and believed that anyone could pursue a career in science, if he/she is provided with a nurturing experience early in life. She felt students from her community do not consider a career in science because there are no role models in the community. She stated that she is always telling her son how he can do anything and be anything he wants to be if interested. She, along with a friend, suggested that community science experiences be provided for the children. This suggestion led to the organisation of a community science program for the children of the community.

The interesting point is that the two mothers had sons who attended the same middle school and the two families lived in the same community, yet these mothers held opposing viewpoints on this issue. The mother with the encouraging comments believed that minority status should not be a deterrent to assuming a career in science, if opportunity presents itself to any individual who has received adequate preparation. Her son, also, stated that he believed anyone could become a scientist. It is the responsibility of the parent and the teacher to help children develop a positive self-concept. Hill, Pettus, and Hedin (1990) state that self-concept and a feeling of self-efficacy are two important personality variables that are related to an interest in science and mathematics.

The other young man in the interview shared the same discouraging comments as his mother. He did not possess a positive self-concept about going into science. He stated that he could not imagine himself as a scientist and told me that only the smartest students become scientists. I asked him why couldn’t he become a scientist and he replied, ‘scientists are too smart’.

If our educational goals include providing under-represented groups access to the field of science, then it is critical that we understand the beliefs they adhere to when they reflect upon the question, ‘Who can become a scientist?’

Implications for educational practice

Menacker, Hurwitz and Weldon (1988) concluded from their study of Chicago elementary schools that most inner city parents had negative school experiences themselves and did not see the school as a ‘place of hope’ for their children. The work of Ogbu (1983) might offer an understanding as to why some individuals commit to a feeling of hopelessness and a lack of control over their lives. Ogbu (1983) identifies two mental frame of references. One is the 'castelike' minority who is caught in a web of inferiority and self-defeat that discourages one from living up to his or her potential. The other is the 'immigrant' minority who sees education as a golden opportunity. Parents who assume the former way of thinking about educational issues are perpetuating this feeling of hopelessness in their children. Their beliefs influence the way their children view the world.

Ogbu (1983) further argues that whenever a subcultural minority has historically experienced caste-like restrictions in its access to legitimate power and status within a dominant culture, the adult members of the subculture develop different, largely negative, cultural attitudes toward such settings – attitudes that may be transmitted to its children.

It might even be easy for some educators to conclude that parents who exhibit a feeling of hopelessness or who have a discouraging attitude are parents who don’t value education, when in reality, other factors may be operating. According to Greenwood and Hickman (1991), some parents feel powerless to influence the school. Other parents believe they do not have knowledge or social skills (Greenwood and Hickman, 1991).

The obvious conclusion is that there is an apparent need to strengthen the lines of communication and relationships between the school and the home, or more specifically, the teacher and the parent. Discouraging parental attitudes can undermine the efforts of the teacher and the schools whose role is to provide a positive and encouraging learning environment.

The research on parent involvement suggests clearly that the home has at least as much influence on student learning and behaviour as does the teacher and the school (Greenwood and Hickman, 1991). Meaningful parent participation is essential for effective schooling (Comer and Haynes, 1991). Therefore, at a time when substantial efforts have been placed on encouraging more minorities to go into science, it is definitely desirable and advantageous to involve parents in our efforts, especially parents whose experiences have caused them to have a feeling of hopelessness. The messages that these parents convey to their children, many times, may be messages that are not consistent with our educational goals.

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PROJECT 2000+

Phase 1 Materials

Can you help?

To ensure that Project 2000+ takes note
of all developments around the world,
can you help by bringing our attention
to any relevant materials that exist?

Of interest is material related to the 6 focus areas.
Please indicate which focus area.
The material may be journal articles, research papers,
material from projects, teaching or assessment ideas,
or local resource materials that have a bearing on
scientific and technological literacy
in the 21st century.

Non written materials are also very relevant,
including videotapes. The criteria is that
they relate to scientific and technological literacy
for the 21st century.

Please send any material
that you consider to be relevant to:

Dr Jack Holbrook
Project 2000+
Science and Technology Education Unit
UNESCO
7 place de Fontenoy
75700 Paris
France

If it is not possible to send the actual materials,
please let us know about them and
where they can be obtained.
Materials should be in English or French.
If materials are in another language,
please send with a short abstract in English or French
which describes the content.

Don't forget that materials, articles, etc
should be forward looking
and be capable of being relevant in the 21st century.

Project 2000+ is looking at the 21st century.
The Good Primary Science Teacher: What some Bruneian school children say

by Cynthia P Tendencia
Universiti Brunei Darussalam

Introduction
Teachers normally find some difficulties in giving a quick, spontaneous response when confronted with the question 'Are you a good teacher?' The Asian woman is quite demure in responding to this. Thus, the problem of who we should ask about the teacher, arises. Well, why not ask the schoolchildren. So, in an attempt to have a picture of a good primary science teacher as perceived by Bruneian schoolchildren, 140 of them from seven elementary schools were asked to respond in written essay form to an assumed situation wherein they had to describe the primary science teacher they would like to have.

The essays were analysed initially to identify the acts, attributes, behaviours and other characteristics of the chosen science teacher. These were tentatively labelled 'descriptions'. Then these descriptions were grouped and main headings were evolved which eventually were used as the three major categories of descriptions: (1) teaching skills; (2) personal qualities; and (3) discipline. Interviews were later conducted to verify the interpretations of the descriptions.

What is a good primary science teacher?
'I want a teacher who is very kind and gentle. I don't want her to be late for school to teach science. She should do interesting and exciting experiments. I like her to be fair to us and teach us very well. If she teaches us about animals or plants, I want her to bring to school some pictures or samples of what we have studied. I would like her to stop naughty pupils from fighting and destroying our experiments.'
(Md Erwan, 11 years old)

In the children's description of their preferred primary science teacher, there was greatest mention of the teacher's teaching skills, followed by personal qualities and then by discipline.

Primary science teaching skills
A total of 18 descriptions of teaching skills were derived from the essays.

These are summarised under 12 categories shown in the table below.

This article is an excerpt from the article of the same title published in the Proceedings of the 7th ICASE Asian Symposium.

| Teaching skills of a good primary science teacher as identified from 140 essays of Bruneian schoolchildren |
|---------------------------------------------------------------|---------------------------------------------------------------|
| **Skills** | **Rank** |
| Asks questions; allows children to also ask questions | 29 5 |
| Explains clearly and communicates well | 85 2 |
| Gives fair marks and grades | 4 11 |
| Gives notes, exercises, assignments, homework, project work and tests | 38 4 |
| Gives rewards and treats to those who do well in class and exams | 2 12 |
| Makes lessons interesting with stories and jokes | 20 7 |
| Manipulates science apparatus | 6 10 |
| Provides extra class, revision, tuition and remediation | 7 8.5 |
| Records interesting events in class like taking snap shots | 7 8.5 |
| Supervises individual and group work, points out mistakes; helps children at work | 28 6 |
| Uses experiments, field trips and visits, demonstration and activities | 133 1 |
| Uses audio-visual aids | 53 3 |
International Model Solar Car Challenge

On the lonely stretches of the sunburnt Stuart Highway in November 1993, vehicles powered only by the sun will slip through the air at speeds in excess of 100 km per hour in the Darwin - to - Adelaide World Solar Challenge in Australia.

This international event has been an unqualified success. The race has also generated tremendous interest among students throughout the world in not only these novel vehicles, but also in the many other renewable energy technologies.

In response to this interest, another event for our younger inventors will be held in conjunction with the 1993 World Solar Challenge.

The 1993 International Model Solar Car Challenge will bring together students from all over the world in a special competition to test their model vehicles powered by solar energy.

This event follows the successful Victorian-based Model Solar Car Challenge in 1990 and 1991. Teams in almost all Australian states and territories will hold state-based events to qualify model solar cars for the international event.

The success of these events will provide a significant representation by all Australian states and territories at the International Model Solar Car Challenge in 1993. New Zealand students will also participate as well as students from Japan, Europe and the US.

Why solar cars?
Teachers and students are looking for innovative ways to teach and learn about environmental issues. One of the most pressing environmental issues is the use of fossil fuels and the resulting problems of pollution, atmospheric change and resource depletion. One of the key solutions to these problems is the development and utilisation of energy-efficient and renewable energy technologies.

Generating electricity from solar cells is an emerging and important renewable energy technology. Many scientists have been successful in improving the technology of solar photovoltaic cells and believe that they have an important role to play in meeting the energy needs of our society.

Students need to be aware of the potential of photovoltaics and other forms of renewable energy so that they can make informed decisions about energy choices as they become the adults of tomorrow.

The 1993 International model Solar Car Challenge fits easily into science and technology studies where students design, construct and test model solar cars. The event and project can also develop links with Social Education, Environmental Education and Geography areas, while also providing a high degree of student motivation.

Students involved in previous model solar car activities have shown substantial personal development with organisational skills, co-operative group work, research skills and report presentations.

Project materials
An innovative package of materials has been developed to facilitate the construction and testing of model solar cars in a school-based multi-disciplinary activity. The package of materials includes a solar module, resource book and videotape, and provides a broad range of photovoltaic experiments and activities to be incorporated into on-going school programs and curricula. A practical guide is also available using ideas generated in the 1990 and 1991 events.

For further information
Contact: Mr Dodwell Keyt
23 Perth Street Murrumbeena
Victoria 3163 Australia
Fax (international) +61-3-569-0151
NEW ICASE PUBLICATION

Sustainable Development for a New World Agenda

PROCEEDINGS
OF A CONFERENCE

Winnipeg, Manitoba
Canada
October 17-20, 1990

Edited by John E Penick
and John R Stiles

This new publication, published jointly by STAM, CASE and ICASE, is a serious look at sustainable development and important reading for anyone involved in teaching, curriculum development or developing in-service teacher education courses.

Copies at a cost of US$10.00 including postage can be ordered from:

Dr Jack Holbrook, Executive Secretary, ICASE
Science and Technology Education Unit
UNESCO, 7 place de Fontenoy
75700 Paris, France

or

Dennis Chisman, Honorary Treasurer, ICASE
Knapp Hill, South Harting, Petersfield GU31 5LR, UK

John Penick, Science Education Center
University of Iowa, Iowa City IA 52242, USA

Evhan Uzwysyn, Home Schooling Office
1970 Ness Avenue, Winnipeg, Manitoba, Canada R3J 0V9

Cheques payable to "ICASE"

One of the major sections in this new publication includes papers on Education for Sustainable Development.

Topics include:

• The links between education and sustainable development

• Environmental education 1972-1992

• National round-table on the environment and the economy

• Mandates for environmental education

• Point of view on environmental education

• Education for sustainable development

• Geology education and science development in less developed countries of the world

• STS - environment - problem solving

• Beyond STS science education - adding the environment: a Saskatchewan approach

• Hazardous waste education in elementary school

• Exemplary environmental programs in the United States

• The world in the hands of children

• The future direction of sustainable development in the curriculum

These and other topics dealing with environmental problems and solutions will be of interest to teachers, curriculum developers and teacher educators.
ICASE is keen to arrange regional or world events for the benefit of member associations. If your association or organisation is interested in hosting an international seminar, workshop or conference, contact the Executive Secretary or your Regional Representative. To gain ICASE endorsement, the meeting must be international in nature, open to member associations, and, while all sectors of the science education community should be encouraged to participate, must be relevant to classroom teachers.

1992

December 14-17
14th Biennial Conference of the Asian Association for Biology Education
Location: Deakin University, Melbourne, Australia
Contact: Peter Brown, Convenor, AABE Conference, Deakin University, Rusden Campus, 662 Blackburn Rd, Clayton, Victoria 3168, Australia.
Anyone with an interest in biology education and environmental management is invited to attend. The theme is ‘Environmental Management in Asia – Training, Education and Research’

December 17-21
Twelfth International Conference on Chemical Education
Location: Bangkok, Thailand
Contact: Dr Somjai Wichaidit, The Secretariat - 12th ICCE, c/o Research Centre, Faculty of Medicine, Ramathibodi Hospital, Rama 6 Road, Bangkok 10400, Thailand
The theme of the Twelfth International Conference on Chemical Education will be Chemistry in Transition and it is hoped that the participants will interpret this in many different ways. This biennial Conference, to be held for the first time in South East Asia, is organised by the Committee on Teaching of Chemistry of the International Union of Pure & Applied Chemistry, and The Chemical Society of Thailand in cooperation with UNESCO. It is attended by chemistry teachers at both high school and university levels who wish to improve their teaching and to learn from one another techniques and experiences.

January 3-8
International Conference on Science Education in Developing Countries
Location: The Amos De-Shalit Israeli Science Teaching Center, Israel
Contact: Conference Secretariat, ORTRA Ltd, 2 Kaufman St, PO Box 50432, 61500 Tel-Aviv, Israel (conference arrangements) or Dr Avi Hofstein, Department of Science Teaching, The Weizmann Institute of Science, Rehovot 76100, Israel (academic correspondence)
This international conference on the theme "Science Education in Developing Countries: From Theory to Practice" will review past experiences and achievements in science education and plan for the 21st century with a special focus on developing countries. The conference will feature plenary lectures, symposia, poster sessions, workshops, exhibitions, informal discussions, social events and local visits. Topics for symposia and plenary lectures will focus on current research on learning and teaching and its implications for (1) the learner, (2) the teacher, (3) the classroom, and (4) the curriculum.

March 21 - April 2
Science Education in a National Curriculum: An International Symposium
Location: University of York, UK
Contact: Your nearest British Council Office or Courses Department, The British Council, 10 Spring Gardens, London SW1A 2BN, UK.
There are vacancies for 30 participants. Topics include: building a national curriculum; new science curricula in secondary schools; styles of curriculum development; evaluation of science curricula; impact and research on developments in science curricula; student assessment; changing demands for staff development; links between industry and science education; the role of national and international agencies in science education.

1993

January 3-6
ASE Annual Meeting
Location: Loughborough University, UK
Contact: Annual Meeting Secretary, ASE Headquarters, College Lane, Hatfield AL10 9AA, UK
Full details of this large international event have been circulated in Education in Science, a journal of the Association for Science Education.

March 25-30
Sixth International PATT Conference
Location: Motel Eindhoven, The Netherlands
Contact: dr Jean de Vries, Pedagogical Technological College, PO Box 826, 5600 AV Eindhoven, The Netherlands, Fax 31-40-440045.
The aim of this conference is to exchange ideas and information on theoretical and practical implications of the implementation of environmental issues in technology
education according to the subthemes: (1) Pupils’ attitudes towards technology and the environment; (2) Environmental issues in primary and secondary technology education; (3) Gender aspects of environmental issues in technology education; (4) Environmental issues in the education of technology teachers.

April 10-24
Edinburgh International Science Festival
Location: Edinburgh, UK
Contact: Edinburgh International Science Festival Ltd, 1 Broughton Market, Edinburgh EH3 6NU
The program for the fifth Edinburgh International Science Festival will span many themes ranging from the environment to space, and high technology to health but, perhaps most importantly, each of the 300 plus public events will explain – in jargon free language – how topical issues within each theme affect everyone. A major international conference focusing on initiatives taken by a wide range of organisations, in many different countries, to improve communications between scientists, the media and the public will be one of the highlights.

April 21-25
International Conference on Geoscience Education and Training
Location: University of Southampton, UK
Contact: Mrs Esther Johnson, GEOED Conference Secretariat, Department of Geology, University of Southampton, Southampton S09 5NH, UK
The Association of Geoscientists for International Development (AGID) and the Commission on Geoscience Education and Training (COGEOED) of the International Union of Geological Sciences are convening this international conference with the support of ICASE. Themes include: geoscience education in schools; higher education; geoscience training for business, industry and public service; and public understanding of geoscience. The conference is open to all those with an interest in geoscience education and training - including practitioners and those involved in administration, course development, and the supply of resource materials.

June 27 - July 3
VII Pacific Science Inter-Congress
Location: Okinawa Convention Center, Okinawa, Japan
Contact: VII Pacific Science Inter-Congress, c/o Section of International Affairs, University of the Ryukyus, 1-Senbaru, Nishihara, Okinawa, 903-01, Japan
The Symposia will be organised around the theme The Pacific: Crossroads for Culture and Nature and subthemes (1) Cultural Interchange among Pacific Peoples; (2) Speciation, Dispersal and Conservation of Species in the Pacific; (3) Towards Appropriate Technologies and Policies for Development and for the Conservation of Natural Environments in the Pacific. Scientific sessions organised by the Scientific Committees of the Pacific Science Association focus on a range of science disciplines and issues, including Science Communication and Education.

July 5-9
CONASTA 42
Location: Sydney, Australia
Contact: Jenny Jones, Convener CONASTA 42, PO Box 787, Potts Point, NSW 2011 Australia
The Australian Science Teachers Association invites you to participate in the 42nd annual conference of the Association. The theme of ‘Science – Teaching it Better!’ aims to highlight the part that teachers can play in fostering in their students an interest in and understanding of science. Four subthemes will deal with both primary and secondary issues: (1) Science updates – recent exciting developments and their impact; (2) Science education research – what it has to offer the classroom teacher; (3) Science teaching for effective learning – how do we engage minds in the classroom?; (4) National initiatives. The program includes theme lectures, interactive workshops, seminars, field workshops, ‘wandertimes’ and poster presentations. A comprehensive display of resources useful to science teachers will be presented by publishing, audiovisual, equipment and computing companies.

July 6-11
Project 2000+ International Forum
Location: Paris, France
Contact: Dr Jack Holbrook, ICASE Executive Secretary, Department of Curriculum Studies, University of Hong Kong, Hong Kong
This worldwide conference, organised by ICASE in conjunction with UNESCO and other international bodies is the second phase of the three phase Project 2000+ (refer to article in this issue for more details of this project). A number of international and regional conferences are generating input into this international forum. The theme of the forum addresses the issue of scientific and technological literacy for all. Sessions will establish agendas for future action. Attendance will be by invitation only (500 participants). Names are now being sought from a wide variety of organisations with an interest in science and technology education (see next page). The forum plans to issue statements to affect political visibility for science and technology education for all as a requirement for national development, and provide a framework for major programs of action in science and technology education involving governments, IGOs and NGOs.

July 27 - August 10
London International Youth Science Forum
Location: London, UK
Contact: LIYSF, PO Box 159, London SW10 9QX, UK
The Science Forum is the principal annual meeting in Britain of young scientists. Over three hundred students attend from some fifty nations to make this an international event of major significance. The program features lectures, seminars and demonstrations from leading scientific names, and an extensive range of visits to university and industrial research establishments.
International Forum

Scientific and Technological Literacy for All

Phase 2 of Project 2000+

Paris, France

6-11 July 1993

This International Forum is the Second Phase of Project 2000+, an international project on scientific and technological literacy for all, which addresses the following 6 focus areas:

1. The nature of, and the need for scientific and technological literacy
2. Scientific and technological literacy for development
3. The teaching and learning environment for scientific and technological literacy
4. Teacher education and leadership for scientific and technological literacy
5. Assessment and evaluation for scientific and technological literacy
6. Non formal and informal development of scientific and technological literacy

Attendance will be by invitation only and limited to 500 participants. Names are now being sought from:

- National EFA (Education For All) Groups
- National policy makers overseeing science and technology education
- INISTE centres
- Project coordinators and field workers for organisations
- Science and technology teacher associations
- Institutions, centres, universities and colleges involved in science and technology curricula, examinations and teacher education
- Science and technology out-of-school centres and organisations
- Non formal science and technology educational organisations
- Industrialists
- Persons from the mass media interested in Project 2000+

Organisations, associations and institutes are invited to submit names of suitable participants to the Project 2000+ secretariat. A short description of each person should also be included covering:

(a) activities of the person nationally (within organisation if appropriate)
(b) international involvement (at conferences, research, projects, etc)
(c) which Project 2000+ focus area is of greatest interest

Individuals can also apply. Individuals will be selected based on paper abstract, submitted by the end of September 1992, related to one of the focus areas.

Selection will take place at the end of 1992 and will be finalised by approval of the Steering Committee at the end of January 1993.

There will be a US$100 Registration Fee for each participant to help defray material costs. This will be payable to the Project 2000+ Secretariat on receiving the invitation. For further information, contact: Dr Jack B Holbrook, ICASE Executive Secretary, Science and Technology Education Unit, UNESCO, 7 place de Fontenoy, 75700 Paris, France.
Extending and improving education in science for all children and youth by assisting member associations throughout the world

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10 Hawken Street  
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Australia
Science Education International is the Quarterly Journal of the International Council of Associations for Science Education. ICASE was established in 1973 to extend and improve education in science for all children and youth by assisting member associations throughout the world.

This journal provides a means for associations, institutions, centres, foundations, companies and individuals concerned with science education, to share perspectives, concerns, ideas and information which will foster cooperative efforts to improve science education, and which will serve as a chronicle of the advancement of science education throughout the world.

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Dates for Receipt of Contributions
Issue: Closing Date:
March 1 February
June 1 May
September 1 August
December 1 November

ICASE News 2
Feature Articles 5
Disturbing the Boundaries: The Science/Literature Membrane
P Lamb & P Strube
Science Activities to Develop Transcultural Understandings
M G Hickey
Secondary School Biology in Russia V I Sivoglasov
Constructivism and Science Education Reform R E Yager

Science Education Around the World 15
Research for Teaching and Learning 16
Looking at Science Experiments through the Students’ Eyes
A Cachapuz & I Martin

Science Teacher Education 19
A Unique Indonesian Program for In-Service Education
E Van den Berg

Primary Science 23
Teachers’ Views on Effective Primary Science in Nigerian Schools J O E Otuka

Science Technology Society 27
STS-Environment-Problem Solving W Soprovich

Resources 31
Calendar 32

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10 Hawken Street, Monash ACT 2904, Australia
Individuals A$22 per annum, Libraries A$44 per annum
ICASE Secretariat moves to Paris

The intensity of work associated with the major ICASE/UNESCO initiative, Project 2000+, continues to increase as Phase 2 of the project draws nearer.

In order to facilitate the planning and organisation of the International Forum which will form Phase 2 of Project 2000+, Dr Jack Holbrook has moved from Hong Kong to Paris. The International Forum, which will be held at UNESCO headquarters in Paris, 6-10 July 1993, will involve 500 invited delegates, including representatives of ICASE member associations.

Please forward all correspondence for the ICASE Executive Secretary to:

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75700 Paris
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Fax: +33-1-40 65 94 05
e-Mail:EDEAP@FRUNES21.BITNET

ICASE World Activity Day

Accompanying the June issue of Science Education International will be a special feature reporting some of the activities of World Activity Day which was held throughout the world on Thursday 14 October 1992. The activities focused on the theme of space, on the occasion of ISY (International Space Year).

The Editor has received several essays which have been selected by member associations and ICASE regional representatives as worthy of publication. The best of these will be published in this special feature. Certificates have been sent to through regional representatives to the students who wrote the winning entries.

The Editor has also received a report by students who conducted the activity to calculate the Earth's diameter.

If member associations have not yet passed on any entries, reports, etc to the ICASE regional representatives, please do this now so that these can be incorporated into the special feature. Alternatively, send entries, and any reports of World Activity Day in your area direct to:

Brenton Honeyman
Editor, Science Education International
10 Hawken Street
Monash ACT 2904, Australia


Member associations are requested to assist with nominating individual women and men who have made a significant contribution to science education at the primary, secondary or tertiary levels. It is hoped that in this second edition, there will be many more entries by educators from developing countries, and from officers who are making a substantial contribution through their science teacher association, etc. Either copy the form distributed with the December 1992 issue of this journal and send it to your nominees, or provide the Editor (Brenton Honeyman, 10 Hawken Street, Monash ACT 2904, Australia) with names and addresses so that forms can be sent.

Photo: Three science educators from Thailand were among the delegates at the 1992 annual conference of the Australian Science Teachers Association held in Perth, Australia. During the week long meeting, they met with two ICASE officers. From left to right: Terraporn, Sombat, Brenton Honeyman (Editor, ICASE Journal), Maris Silis (ICASE Australasian Representative), Kanya.
New Subscription Rates
for Science Education International

Since the first issue of the ICASE Journal in March 1990, individuals and libraries have been subscribing to Science Education International.

Due to increasing production and postage costs, 1993 subscription rates have been increased to:

**Individual**
- £10.00
- US$17.50
- A$22.00
- CAN$20.00

**Library**
- £20.00
- US$35.00
- A$44.00
- CAN$40.00

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ICASE Membership Continues to Grow

**Institute of Earth Studies**
ICASE welcomes the Institute of Earth Studies as a new member. The Institute is located at University College in Wales, UK. The correspondent is:
Dr Denis Bates, Editor ESTA
Institute of Earth Studies
University College
Aberystwyth
Wales SY22 303, UK

**Science Education Association, Indonesia**
The Science Education Association recently joined ICASE following contact with ICASE officers at the 12th International Conference of Chemical Education held in Bangkok in December 1992. The correspondent is:
Dr Eddy M Hidayat
Biology Department
IKIP Bandung
Jl Setiabudi 229
Bandung, Indonesia

**Mahanakorn College, Thailand**
Another member arising from contact with ICASE officers at the 12th International Conference of Chemical Education, is Mahanakom College in Bangkok. The correspondent is:
Dr Janchai Yingprayoon
Physics Department
Mahanakorn College
Nongkik
Bangkok 10530, Thailand

---

The ICASE Commitment to Primary Science

The ICASE Stepping into Science Project, led by Sue Dale Tunnicliffe, continues to widen its impact in many places around the world. A Stepping into Science Newsletter, available on a subscription basis (£5, US$8, A$10 or Can$9), assists the project to share news of events and ideas for primary classrooms. The photo below shows Sue Dale Tunnicliffe conducting a Stepping into Science workshop at Cincinnati University during October 1992.
International Specialist Seminar

**Science, technology and society - appropriate science education for the twenty-first century**

*6-16 September 1993, Oxford*

This seminar will build on the highly successful course held in Oxford in September 1990, and yet it will be self-contained for those who are new to this field of science education. It will be directed by Dr Joan Solomon, University Lecturer in Research at the Department of Education Studies and author of several books on Science, Technology and Society. Mr Terry Allsop, Lecturer in Chemistry Education at the Department, will be tutor to the course.

The following issues will be among those discussed:

- The nature of STS as education
- Objectives and the evaluation of courses
- Information knowledge and Public Understanding of Science
- Industry and STS
- STS in developing countries
- Law, values and decisions about the environment
- New curriculum materials
- Teachers and in-service education

This seminar is intended for experienced science teachers, educationists, and government officials involved with curriculum planning and implementation and inservice work with teachers.

There are vacancies for 30 participants.

Seminar fee: £950; accommodation charge: £490; total fee: £1440.

The seminar will be held at the Department of Educational Studies, University of Oxford. Participants will be accommodated in single study bedrooms at the nearby Lady Margaret Hall, one of the university colleges. Bathroom facilities will be shared.

*Further information and application forms are available from local British Council offices or from Courses Department, The British Council, 10 Spring Gardens, London SW1A 2BN, UK (telephone: +44 (0)71 389 4264/6252/4162; fax: +44 (0)71 389 4154).*

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Disturbing the Boundaries
The Science/Literature Membrane

by Peter Lumb & Paul Strube

Abstract

A collection of over 200 short stories, written for the National Short Story Competition of the RACI, are examined for what they reveal of students’ images of science and scientists. A discussion of the place of science in fictional writing is carried out, using material from actual stories. This is placed in the context of other research on students’ perceptions of science, and has implications for concerns about gender in science education.

Science remains an activity that is highly competitive, macho and exclusive.
(Suzuki, 1987, 157)

Introduction

Constructivist theories of learning have encouraged us to look for the connections learners make when information is received. In science education, we have naturally tended to concern ourselves with the connections between scientific concepts. Research is beginning to uncover the connections between incoming scientific information and non-scientific content of the mind (Gunstone, 1990). Concept maps have been valuable here, showing the kinds of connections that are made when such words as ‘energy’, ‘force’ and ‘living’ are explored.

From 1988 through the current year, the authors have organised a short story competition for science students in Australian secondary schools. Sponsored by the Royal Australian Chemical Institute as part of its National Chemistry Week activities, the competition is based around writing a fictional short story in which chemistry played a major role. (Strube, 1989)

An objective of the competition was to stimulate imaginative interest in science, and to provoke thought among students about the ways in which science was contiguous with real and imaginative experience. Certainly, the products of this short story competition have suggested that science stories provide rich possibilities for humanistic exploration. The competition revived ideas about the ‘two cultures’; they seem clearly evident, and separate, in many of these stories. Both cultures, it seems, have much to gain if science teachers feel able to involve humanities teachers and secondary students in a joint writing enterprise. On the whole, stories from English classrooms are quite different to, and remote from stories from science classrooms. The two cultures are so distinct in many students’ minds that ideas must be written in two separate styles, which cannot be reconciled even within the one story.

This paper looks at the over 229 short stories entered in 1988 and 1989. It examines them for their images of science and of scientists portrayed. There was no attempt to instruct the authors to present what they truly believed scientists are like, and so the views represent how student authors ‘choose’ to portray scientists.

Nevertheless, there are some interesting revelations about the way scientists are imagined by students, and about the social world they inhabit. Attitudes, values and behaviours of (mostly) male scientists appeared consistently and clearly in student stories.

In order to see if these results were generalisable, it was necessary to conduct a literature survey. An attempt was made to uncover other people’s work on the image of scientists in society and to place the secondary students story findings alongside these. Were these other images as strong and consistent as those of the secondary school writers?

The stories

Below are some of the findings from the short story competitions.

• In 1988, 117 stories were submitted, and in 1989 there were 112. The stories came from all Australian states and all year levels were represented, although in the 1989 competition 45% of stories came from year 7 students. In both years relatively few year 12 students have entered.

• There were about the same number of stories submitted by females as by males in 1988, but in 1989 about 66% were submitted by females.

• About one third showed two distinct and unintegrated styles. These were literary fiction style, for example comic book, war, adventure, mythical morality, adventure, romance and adolescent social realism. These literary styles were often alongside classroom or school science textbook styles. This was less noticeable in 1989 because, it would seem the large number of year 7 authors had not assimilated a science-note style into their repertoire of writing style skills.

• In terms of writing craft the stories frequently appeared to be ‘rough draft’ quality. While sentence structure, paragraphing, and spelling skills were in place, the vast majority of stories hung together poorly. They lacked the usual techniques which published short story writers adopt, and which secondary English teachers expect to see from experienced readers and capable writers. (For example, surprisingly few stories had economically but clearly developed characterisation. Few had a clear sense of place or time. Few cohered as stories with a development of tension, then resolution or satisfying mystery, while few had surprising relationships, were witty or particularly funny.)
• However, the fundamental ideas for the stories were often very clever or unusual, given the author's experience in English classrooms. These stories did represent a very different imaginative territory.

**View of sciences/scientists found in the stories**

The stories reveal much about women and girls, and men and boys, and the way they are perceived to relate to each other, (or not), in story contexts which must contain science in society. The stories allow confirmation of other findings about science and its place in society, and thus in education. From these stories it seems that science is associated with men and masculinity. Regardless of who writes the story, women tend mainly to appear in very traditional nurturing roles.

Science seems 'penned-off' in two significant ways. First, for many students, (about one third), it was impossible to get their characters to discuss science processes or to 'play with' or argue scientific ideas, in any kind of sociable way. Textbook notes had to be inserted in the place of dialogue. This proportion of stories is even more striking as so many stories were set aside from consideration because they simply didn't contain science at all.

Second, and more obvious, science appeared as 'highly competitive, macho and exclusive'. Boys, quite literally, can't imagine girls or women doing science that is in any way connected with a laboratory, and barely at all outside a laboratory. (cf Table 1 No 4, 8). No boys in any age group wrote stories with females as protagonists or with female-only characters. (cf Table 1 No 6).

Girls who submitted stories, can't usually imagine girls or women who are involved in scientific activities, or having other than traditional family, nurturing roles. (cf Table 1 No 4).

Boys and girls, however can imagine men and boys being involved in laboratory science and, in addition, using science in a great variety of active, adventurous ways. Fifty percent of our male authors had men in laboratories, and seventy five percent had male leads and almost exclusively male characters populating the cast. Only occasionally did a 'token' female appear in any of the male authored stories.

Over the years of the competition boys and men did science as detectives, barristers, business men, hunters and gatherers, crooks, soldiers, spacemen, school boy adventurers, as tourists in predicaments, journalists, famous scientists, professors, fathers, farmers, and science teachers. By contrast, of the two 1988 female authored stories with woman laboratory scientists, one begins apologetically, as follows:

"Samantha woke up feeling very excited, as today was the day she was doing an important experiment (well to her anyway!) at her laboratory."

Among the 1988 stories, of the girls or women who do science outside the laboratory, in two stories perfume is manufactured and sold, farm animals' deaths are explored by a woman farmer, a cure is found for chocolate addiction, Coca-Cola poisoning is remedied, and there is a love story and a detective at work. Among the 1989 stories by female

| TABLE 1 | **Australian Secondary Science Short Stories 1988, 1989** |
| --- | --- | --- | --- |
| **Story (N=229) Characteristics** | **Female author** | **Male author** |
| | 60.8% | 39.2% |
| 1 Chemical fantasies, ie chemicals with personal qualities | 26.6% | 21.6% |
| 2 Nuclear horror, usually set in the future | 4.9% | 5.7% |
| 3 Domestic/family science, science in cooking, hair care, perfume making, etc | 38.8% | 6.8% |
| 4 Women in roles outside the family, excluding school girl role | 16.5% | 4.5% |
| 5 Male lead, mostly all male characters, including narrator when indicated | 36.3% | 75% |
| 6 Female lead, mostly all female characters, including narrator when indicated | 17% | 0% |
| 7 Men as laboratory scientists | 8.2% | 50% |
| 8 Women as laboratory scientists | 4.1% | 1.1% |

*Note: Stories often had more than one of the characteristics listed*
authors, there were girls or women who were torture victims, or who were dying, two young scientists (who were 'taking the micky out of a chauvinistic male professor-boss'), an English teacher, a number of science teachers, a maid, a President of the United States of America and an oil rig worker.

Among male authors in 1989, there was one female scientist, and two female science teachers. Other females appeared as wives or sisters (no girl-friends!). Stereotypical behaviour abounds. Men and women seldom interact, and almost never interact co-operatively or equitably.

Wider findings

When primary school children in a number of countries are invited to draw a scientist, and these drawings are scored with a standardised 'Draw a Scientist Test' procedure, the following picture emerges — refer to Table 2 below.

Chambers' findings held constant in large samples in Canada, the USA and Australia. In total, 4807 students were involved, 49% of whom were girls. No boys drew women-as-scientists and only 28 girls did. Australian secondary age student writers, several years on, have almost identical images of science and scientists although more science gets done in the stories outside laboratories.

In a literature review, McDonald and Bridgstock (1982) create a composite picture of scientists. The following attributes are central and persistent.

In general scientists are seen as possessing the positive qualities of intelligence and dependability and to be valuable and hard working. However, they were also seen to be cold, emotionally inhibited, rather boring, unsociable and unimaginative.' (McDonald & Bridgstock, 1982, 75)

McDonald and Bridgstock used qualitative, open-ended interviews with a sample of 55 Australian tertiary students, in an attempt to determine whether or not the strength of previous stereotypes was an artefact of the tools used.

These authors state that the opinions offered by student respondents were a good deal milder than expected. The 'icy-robot' image was confirmed, and generally students viewed scientists as 'conservative, or narrow-minded, male chauvinistic or tending to stick together.' (ibid, 1982, 77)

They also report that in Australia the image of the scientist has become entangled with that of the 'Ocker'.

The samples of interviews included in their article hardly seem to indicate a 'milder' stereotype; eg 'ocker-macho loudmouth engineer type'; 'proper Australian males who swear, drink and screw a lot'; 'basically conservative in their way of dress, political beliefs and attitudes to women and ethnic groups'. (ibid, 1982, 78)

The authors conclude that:

'The results seem to confirm that the 'core' of the scientific image exists, though in a somewhat milder form than it has usually been portrayed. The 'core' has however picked up some additional attributes that can hardly be regarded as favourable; they include the 'male chauvinist' tag for scientists and at least in Australia - the association with the Ocker image.' (ibid, 1982, 78)

Emens McAdam (1990) examined 200 books written for children and young adults, in an effort to uncover the image of the scientist they portray. She decided that 'the wild extravagances described in books are seldom met in real life'.

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**TABLE 2**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>1</td>
<td>Laboratory coat, usually but not necessarily white</td>
</tr>
<tr>
<td>2</td>
<td>Eye glasses</td>
</tr>
<tr>
<td>3</td>
<td>Facial growth of hair, including moustaches or abnormally long side burns</td>
</tr>
<tr>
<td>4</td>
<td>Symbols of research, scientific instruments and laboratory equipment of any kind</td>
</tr>
<tr>
<td>5</td>
<td>Symbols of knowledge, principally books and filing cabinets</td>
</tr>
<tr>
<td>6</td>
<td>Technology, the 'products' of science</td>
</tr>
<tr>
<td>7</td>
<td>Relevant captions, formula, taxonomic classification, the 'eureka' syndrome</td>
</tr>
</tbody>
</table>

Chambers, 1983, 256
(McAdam, 1990, 104). This is consistent with the author's earlier (unpublished) research, that 'there is a definite stereotyped image of scientist in the minds of children and ... that this closely corresponds to the image in fiction that is read by children at that age' (ibid, 1990, 104).

From the literature surveyed, the image of the scientist is strongly and persistently negative and intensely male.

Conclusion
Our involvement with the secondary science stories suggests that science and humanities teachers would do well to explore the social context of science if they, and their students, are to come to grips with negative student perceptions of scientists and their work. There was nothing neutral, objective or value free in the way scientists were imagined in students' stories.

References


About the authors
Peter Lumb has been a teacher of literature and writing in high schools and tertiary education institutions. He has published widely in the field of short stories and resource materials for classrooms. Currently he is a Lecturer in Psychosocial Science, School of Nursing, University of South Australia, Holbrooks Road, Underdale, South Australia.

Paul Strube has been a teacher of science and mathematics in high schools, and is now Lecturer in Bioscience, School of Nursing, University of South Australia, Holbrooks Road, Underdale, South Australia. One of his research interests is in scientific literacy and the connections between science and literature.

The authors can be contacted by writing to the School of Nursing, University of South Australia, Holbrooks Road, Underdale SA 5032, Australia.

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**ICASE AWARD SCHEME**

for outstanding contributions to international science education

Nominations for these awards must be forwarded by member associations of ICASE. For full details of how to forward nominations, contact the Executive Secretary below.

**ICASE Distinguished Service Award**
This award is made to individuals who have a career history of distinguished service to international science education through their involvement in the international activities of local, regional and global science education organisations

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This award honours individuals who have made a significant contribution to international science education through their involvement in international activities at the local and regional levels

**ICASE Association Award**
This award recognises individuals who, within their science teacher association, have made a significant contribution to the international activity of their association

Contact Dr Jack Holbrook, Executive Secretary ICASE, Science & Technology Education Unit UNESCO, 7 place de Fontenoy, 75700 Paris, France
Science Activities to Develop Transcultural Understandings

by M Gail Hickey

Teachers of young children are often quite adept at helping students see connections between and among academic disciplines. These teachers provide imaginative learning experiences which immerse students in the study of a particular topic. One example is the Culture Kit.

Culture Kits

By definition, a Culture Kit is a portable, self-contained 'museum-in-a-box' used by students as they learn about another culture (Hickey, 1992). Each Culture Kit is designed so that students can learn independently or in pairs at their own pace.

In keeping with the Salad Bowl perspective of multicultural education, the emphasis of the Culture Kit is on similarities among and between cultures. When students develop an awareness that:

• all people communicate with one another in a variety of ways;
• all people create stories, music, and crafts which communicate their culture;
• all societies have formal or informal governments and economic systems;
• all societies record peoples' imagining of fantastic beings and fanciful themes; and
• all people celebrate special times in their lives;

through exploring materials and completing activities contained in the Culture Kit, they learn to develop appropriate attitudes about cultures other than their own. With proper planning, they also explore a variety of science concepts and understandings in the process.

Teachers can easily make their own Culture Kits. Materials and activities such as the following should be included:

• a map of the country or area
• maps depicting the country or area within the larger geographic context (France in the larger context of Europe, for example)
• travel brochures
• post cards
• information about national flags, mottos, songs, etc
• examples of coins or other money
• souveniers of all kinds
• travel diaries and/or trip itineraries
• menus, candy wrappers, etc with words and phrases printed in the native language of the country
• photographs
• activity cards directing students to examine materials, explore scientific concepts, and/or research supplementary resources

Materials and activities should be attractively designed and displayed in a portable, durable container. If the container itself is attractively decorated with pictures and words that represent the culture being depicted, students will want to investigate it. Ultimately, students themselves may want to make a Culture Kit of a country or place they have visited.

Some teacher-tested examples for scientific learning

Example – Japan

Include a package of dried seaweed (can be obtained at Oriental food stores). Many Japanese recipes incorporate seaweed, yet children of other cultures usually have not considered seaweed either a source of nutrients or flavor. Encourage students to explore how seaweed is valued and utilized in the Japanese culture.

Example – Mexico

Woven rugs, blankets, ponchos, and other clothing are often seen in Mexico. Include an example of a woven item in the Culture Kit, along with some background reading depicting how weaving is done and with what materials. Provide materials and instructions for children to create their own ‘woven’ project, using bright colours to develop a pattern. Also, include an Aztec calendar. Have students develop their own Aztec calendar, and explain how it is different from the calendars we use. Ask whether 365 is the best number of days to represent one year. Why or why not?

Example – Korea

Provide resources to enable students to explore these questions about the country:

• What is the climate of Korea? Is it different from the climate here? How so? What adaptations would be necessary to survive in a different climate?
• What types of crops are grown in Korea? How does the climate influence the food produced there? Are there any crops we can grow that Koreans can not? What crops do they produce that we can not?

In addition, allow students to make their own kites, using a Korean kite as a model. Develop hypotheses about which kites will fly the highest or the longest, and conduct experiments to test hypotheses.

Example – The Netherlands

Provide resources and materials for students to research lowlands, canals, dikes, windmills, and tulip farming.
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And in conclusion
By developing and using Culture Kits in the classroom, teachers of young children can provide valuable experiences for their students. The Kits allow exploration of cultures other than one’s own through hands-on involvement and, when properly planned encourage children to investigate related scientific concepts. Since Culture Kits are used independently or in pairs, they permit teachers to individualize instruction to a greater degree than is often possible. Creative teachers add to the materials and activities in their kits over time to keep them current and make the activities more stimulating. And extensive teacher testing shows that kids love them!

References

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1992 ICASE YEARBOOK
Science Technology Society
Edited by Robert E Yager
Available now from
Jack Holbrook, Executive Secretary, ICASE
Science & Technology Education Unit, UNESCO 7 place de Fontenoy, 75700 Paris, France
Russian schools are preparing a new generation for active participation in the restructuring and democratization of society. We need well-developed and well-educated persons who are aware of the necessity for continuing self education. Biology, now taught according to new curriculum and programs developed in 1986, emphasizes learning the main biological concepts and leading scientific theories and ideas. Concepts and leading ideas determine course contents and structure and include:

- organic world evolution
- interconnected structure and function in wildlife
- interconnections of the biological systems with the environment
- connection of theory and practice

The biology course is preceded by a course in natural history in primary and early secondary school.

<table>
<thead>
<tr>
<th>Table 1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Time for the Natural History Course in Primary Schools (hours per week)</strong></td>
</tr>
<tr>
<td>Grade</td>
</tr>
<tr>
<td>I-III grades (starts at age 7)</td>
</tr>
<tr>
<td>I-IV grades (starts at age 6)</td>
</tr>
</tbody>
</table>

In the primary grades students study natural history, including seasons and weather, agriculture, plants and animals, and the general structure of the human body. Great attention is paid to personal and social hygiene. Natural history in the secondary school (beginning with grade five, one hour a week) is devoted to the study of physical science, interrelations of living organisms and environment, variety of living organisms and conditions, and necessities for their vital activity. The secondary biology course is divided into five parts:

- Plants (VI Grade - 68 hours; VII grade - 36 hours)
- Bacteria, mushrooms, lichens (VII grade - 8 hours)
- Animals (VII grade - 24 hours; VIII grade - 58 hours)
- Human health (IX grade - 68 hours)
- General biology (X grade - 34 hours, XI grade - 51 hours)

The biology course at some Russian schools isn't divided into traditional parts such as botany, zoology, human anatomy, physiology and hygiene, or general biology. In these schools, we created an integrated biology curriculum where the contents have been simplified. And, much more attention is paid to interrelations between specialized biological disciplines.

<table>
<thead>
<tr>
<th>Table 2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Time for the Biology Course in Secondary Schools</strong></td>
</tr>
<tr>
<td>Grade</td>
</tr>
<tr>
<td>Hours a week</td>
</tr>
</tbody>
</table>

Course content varies according to the grade. VI grade includes information on morphology, vital activity, reproduction and development of flowers, and interactions between plants and their surroundings.

VII grade students study biodiversity and systematics of plants, bacteria, lichens and mushrooms and differences in their structure due to the evolutionary process.

In grades VII and VIII the 'Animals' unit gives information on the variety of animals from Protozoa to Mammals, their structure, functions, systematics, and relationships. Students of IX grade study 'Human body and health', which provides information on the peculiarities of the human body, its vitality, elementary first aid and also on sexual and hygiene problems.

The unit 'General biology', studied during X and XI grades, ends the course of biology at secondary school. This unit provides information on cell biology, genetics, evolutionary theory, biotechnology, ecology, and environmental protection.

After IX grade students may continue their education in secondary professional schools, (3 years) or secondary special technical schools (3 years). Study of general biology at this level is obligatory (73 and 70 hours respectively). Students can also deepen and extend their knowledge in special groups at various extra-school Pupils' Houses, Institutes, and Universities.

In addition, the State Committee on Peoples' Education worked out sixteen on biological and ecological elective courses. These elective courses start from the VII grade with students of VII - IX grades able to choose courses for two hours a week and grade X and XI for four hours per week.
TABLE 3

Elective Biological Courses at Secondary School

<table>
<thead>
<tr>
<th>Elective courses</th>
<th>Hours</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Life of plants</td>
<td>34</td>
<td>VII</td>
</tr>
<tr>
<td>Life of animals</td>
<td>68</td>
<td>VIII</td>
</tr>
<tr>
<td>Human physiology</td>
<td>68</td>
<td>IX</td>
</tr>
<tr>
<td>Outlines of hygiene and sanitation</td>
<td>34</td>
<td>IX</td>
</tr>
<tr>
<td>Outlines of ecology and labour protection</td>
<td>68</td>
<td>IX-X</td>
</tr>
<tr>
<td>Physiology of agricultural animals and zootechnics</td>
<td>34</td>
<td>XI</td>
</tr>
<tr>
<td>Physiology of higher nervous activity</td>
<td>34</td>
<td>X</td>
</tr>
<tr>
<td>Physiology of agricultural plants and plant-growing</td>
<td>34</td>
<td>X</td>
</tr>
<tr>
<td>General biology</td>
<td>136</td>
<td>X-XI</td>
</tr>
<tr>
<td>Wildlife evolution</td>
<td>68</td>
<td>XI</td>
</tr>
<tr>
<td>Molecular biology</td>
<td>34</td>
<td>XI</td>
</tr>
<tr>
<td>Outlines of genetics and selection</td>
<td>68</td>
<td>XI</td>
</tr>
<tr>
<td>Outlines of biotechnology intersubject courses on ecology</td>
<td>34</td>
<td>XI</td>
</tr>
<tr>
<td>Human health and environment</td>
<td>34</td>
<td>IX</td>
</tr>
<tr>
<td>Techniques and environment</td>
<td>34</td>
<td>X</td>
</tr>
<tr>
<td>Man and biosphere</td>
<td>68</td>
<td>XI</td>
</tr>
</tbody>
</table>

Programs of advanced study on different subjects are being developed. In 1986 the new curriculum on biology was designed to provide an extended theoretical and practical study of the subject. The program is introduced from the VIII grade (VIII-IX grades - 4 hours a week; X-XI grades - 3 and 3/4 hours plus 2 extra hours on studying additional units, chosen by the teacher).

**Goals of biology studies**

The main goals of studying biology at school are to:

- ensure the mastering of main ideas of biology as a field of science (structure, vitality of organic world, structure and function of ecological systems, their changes due to human impact)
- form scientific world outlook and ensure the awareness of humankind's place and role in the biosphere
- understand the practical significance of biology as the basis of agriculture, food industry, biotechnology, and environmental protection
- use subject knowledge for professional and career orientation
- form ecologically educated people with responsible attitudes towards nature and readiness to protect it
- form skills and habits necessary for people to extend their knowledge, to develop logical thinking during education and future practice.

Current liberalization of education in Russia allows many schools and regions to work out their own school, city or national curriculums and programs on biology. Most of them are based on the state obligatory program and/or take into consideration the guidelines of biological education in the country. We are optimistic that these new programs of study will help insure that our students are as biologically and scientifically literate as they must be to succeed in the future.

**About the author**

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Constructivism and Science Education Reform

by Robert E Yager

Constructivism is attracting increasing attention as the dominant learning model in educational reform efforts. Ernst von Glasersfeld, the leading constructivist today, has extensive research and writings which are very informative and useful to anyone interested in more effective teaching. His work and influence are central to the universally acclaimed reform movement in mathematics education elaborated in the National Council of Teachers of Mathematics Curriculum and Evaluation Standards for School Mathematics (1989).

Von Glasersfeld traces constructivism back to Vico who, in 1710, described his concept of human learning: "Epistemic agents can know nothing but the cognitive structures they themselves have put together." "To know" means "to know how to make." He substantiates this notion by arguing that one knows a thing only when one can explain it. Such explanations are for others to understand and to use (Vico, 1858). The extensive work of Jean Piaget also supports, elaborates, and exemplifies constructivist ideas. Unfortunately too many took Piaget's results and classification schemes and used them as doctrines to be taught and learned as other material in science is typically taught and learned; this prevented science educators from gaining the full impact of his work.

The crisis in science education of the 80s resulted in major attention and funding for "new" research concerning human learning. The emerging results of these massive efforts have been devastating to existing traditional curricula, instructional practices, and assessment programs in science education. This research on teaching and learning has verified the crisis while also identifying the folly of many correctives undertaken across the world. And, the results brought new attention and support for constructivism — what some now call the Constructivist Learning Model (CLM).

General results from cognitive science research permit the following generalizations:

1. Most persons have naive theories/ideas concerning the natural world (this includes the best students in the educational system, including undergraduate physics majors and engineering students);
2. Each person's explanation of the things around them comes from their own experiences (as opposed to what they are taught);
3. It is extremely difficult to alter a person's own mental constructs (certainly not by merely telling them they are wrong);
4. Altering misconceptions occurs best through personal challenges to the concept, thereby creating situations where the erroneous conception does not explain; and
5. Learning is a social activity; even when an individual constructs explanations for him/herself it must be communicated and validated.

All of these results can be used to support the Constructivist Learning Model. For learning to occur, students (and all persons) must be personally involved and in the end construct meaning for themselves. Meaning can not be "transmitted" from teacher or textbooks to student. What can be transmitted is meaningless terms and simple skills — neither of which can be used out of context. And this is the problem with school science — that which the best students seem to know and express on exams can not be used anywhere else.

The instructional reform called Science/Technology/Society (STS) is based upon the Constructivist Learning Model. The basic aim of the STS approach is engaging students in problem solving activities which they have identified and in which they have some personal stake. They often work individually, but are quickly parts of investigatory teams — sometimes the entire class. As other students provide challenges for given conceptualizations, outside experts are often sought out and used. The last confrontation/challenge is often the current conceptualization of the scientific community. Instead of telling students what these concepts are and using the so-called laboratory to verify what scientists have said, the ideas and the laboratory are used during the investigation as one further check and challenge. The attempt is always to use (and usually alter) the constructs students have when they enter our classrooms.

The Constructivist Learning Model demands new approaches to teaching. As reforms in science education are sought, constructivist ideas suggest such procedures as:

1. Allow student thinking to drive a lesson or entire unit;
2. Shift activities and content plans to fit student responses, interest, and ideas;
3. Encourage student initiation of ideas, display of leadership, and autonomy in planning and doing;
4. Encourage students to expand and follow-up on their ideas;
5. Allow adequate wait-time for students to think and to propose;
6. Encourage group work and encourage students to interact frequently with other students and others outside the particular class;
7. Use open-ended and thought provoking questions; encourage the same from students;
8. Encourage student reflection, analysis, and predictions;
9. Seek out existing student concepts; use these in teaching as opposed to ones from teachers or textbooks; and
10. Offer alternative suggestions and encourage them from other students; use these as challenges to misconceptions.

STS teachers who by definition utilize constructivist approaches use a self analysis scale to judge their successes with constructivist teaching practices for a given lesson or unit. Most are willing to concede that it is impossible to be perfect (right hand of the spectrum) in the thirteen features. The scale is offered for others interested in using the Constructivist Learning Model as a part of reform in their science teaching.

**Self-Analysis Scale**  
the Constructivist Learning Model

1. Who identifies the issue/topic:  
   - Teacher  |  |  |  |  |  | Student  

2. Issue seen as relevant by student:  
   - No  |  |  |  |  | Yes

3. Who is asking the questions:  
   - Teacher  |  |  |  |  | Student

4. Who identifies written and human resources:  
   - Teacher  |  |  |  |  | Student

5. Who locates written resources:  
   - Teacher  |  |  |  |  | Student

6. Who contacts human resources:  
   - Teacher  |  |  |  |  | Student

7. Who plans investigation and other activities:  
   - Teacher  |  |  |  |  | Student

8. Varied evaluation techniques used:  
   - No  |  |  |  |  | Yes

9. Students evaluate themselves:  
   - No  |  |  |  |  | Yes

10. Students apply concepts and skills to new situations:  
    - No  |  |  |  |  | Yes

11. Students take action following study:  
    - No  |  |  |  |  | Yes

12. Science concepts/skills emerge because they are needed:  
    - No  |  |  |  |  | Yes

13. Extensions of learning outside the school in evidence:  
    - No  |  |  |  |  | Yes

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Australia

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Second ICASE Symposium
Education Industry Partnerships
by Jan Hendriks
ICASE European Regional Representative

In September 1990, a very successful symposium was organised in Brussels by ICASE and the European Chemical Industry Council (CEFIC) about Education-Industry liaison. The outcome of the first symposium was the reason why it was decided to organise a symposium every two years.

AKZO, an international company active in the field of chemicals and pharmaceuticals, hosted the second symposium at the AKZO Centre in Arnhem, the Netherlands in November 1992.

The objective of the symposium was to strengthen the international network of people working in education or industry, especially those involved in education-industry partnerships in the area of science and technology.

The symposium provided opportunities for:
- the exchange of information and experiences with partnership programs
- improving and structuring of evaluation models of partnership projects
- stimulating the international involvement of other parties, such as educational media and science museums.

An Advisory Board was established with the following members: Dr J Andriessen, Minister for Economic Affairs, Netherlands; Prof Dr W Hilger, President, VCI, Germany; Mr R Lepischak, President ICASE; Dr F Pandolfi, Vice President, Commission of the European Communities; Mr J Peuchal, President CEFIC; and Dr Ir J Ritzén, Minister for Education and Science, Netherlands. The Symposium Chairman was Mr D Chisman, ICASE Honorary Treasurer. The Organising Committee comprised: Mrs J Pot-de Boer, AKZO; Dr D Bricknell, CEFIC; Drs E J Hendriks, ICASE European Regional Representative; and Ir J Hoekman.

Financial support was kindly provided by AKZO, CEFIC and the Dutch Ministry for Economic Affairs.

43 participants attended the program, representing education, industry, media, museums and publishers. Program highlights included:
- Welcome by Mr Loudon, Chairman, Board of Management, AKZO
- Official Opening by Mr van Oosterom on behalf of the Dutch Minister of Education and Science
- Reports from partnership projects of AKZO and BP
- Evaluation of partnership projects
- Experiences in projects for education and the community – CEPUP, University of Berkeley, USA
- Extension of the scope of education-industry links to science museums – Science Museums of Amsterdam and Paris
- Collaboration between science education and television in the UK
- Parallel workshops to define priority areas for further development during the next two years
- Social program, including a visit to the Wine Museum of Arnhem and a dinner in the Netherlands’ smallest town, Bronkhorst.

The outcomes of the Symposium are reported as follows:

Education-industry partnerships
1. Organisations such as CEFIC and ICASE have a role to play to encourage their members to form and action policies for education-industry partnerships and to prepare guidelines for the preparation of materials and activities for its members.

2. A part of the profits of a company have to be utilised for partnerships and community activities.

3. Partnership programs should include the community (adult education, museums and other out-of-school activities)

4. It is necessary to evaluate input, process and output of education-industry partnerships. The output consists of knowledge and acceptance of science and technology in the community.

5. A multi-media core database to register the partnership activities across Europe should be developed.

Other activities
1. Science museums started the formation of a network to broaden the scope of partnership programs.

2. CEFIC installed a permanent working party on education-industry partnerships, chaired by Dr Manfred Unger, Hoechst, Germany, with Dr David Bricknell (Science and Technology Director of CEFIC) as secretary.

3. Education-industry partnership programs will lead towards technological and scientific literacy, and are linked to the UNESCO ICASE Project 2000.

4. The third Symposium on Education-Industry Partnerships will be hosted by Hoechst, Germany in 1994.
Looking at science experiments through the students' eyes

by António Cachapuz & Isabel Martins

Introduction

A key feature of a constructivist approach to science teaching is that we must understand better the tasks which students are engaging and not just the tasks the teachers think they are giving (Posner, 1982). This requires a careful scrutiny and restructuring of course materials, in particular conventional examples and activities proposed to illustrate central concepts of the discipline. Such a critical analysis should be primarily based on research evidence. According to Driver and Oldham (1986) curriculum development from a constructivist perspective has to incorporate an 'empirical reflexive approach' (p 112).

For example, teachers should be aware of potential problems raised by experiments used to illustrate the concept of chemical change in which the salience of phenomenological aspects of the experiment may induce perceptual dominant reasoning rather than conceptual dominant reasoning. In other words they should be aware of experimental aspects which may or may not facilitate bridging the gap between empirical levels of knowledge and conceptual levels of knowledge.

This seems well to be the case of boiling an egg, often referred to in Portuguese middle school chemistry as a suitable example of chemical change (for details about egg chemistry see Grosser, 1983, 1984). This is because boiling an egg is simultaneously a familiar, cheap, safe and easy experiment to set up in the classroom.

As Arthur Grosser puts it, 'in our folklore, the newlywed who can't cook is exceeded in domestic incompetence only by the toast burner' (1984, p4).

Generally students are asked to identify when a chemical reaction has taken place by macroscopic changes such as the evolution of a gas, temperature or colour changes. In the present case, because of the very nature of the system (namely the existence of a shell) no such changes are directly identifiable and the most tangible feature accompanying the reaction raw egg — boiled egg is the increased hardness of the latter. Thus it may be hypothesized that some pupils perceive the transformation simply in terms of a change of state taking place inside the shell so the semifluid raw egg (egg white is almost all water, 88%) is transformed into 'solid' hard boiled egg, the nature of the initial system being conserved. It should be noted that (provided the egg doesn't crack) another perceptible feature occurring during the heating process, i.e air bubbles which escape through the shell, is compatible with a physical change (decrease of internal pressure).

The goal of this paper is to investigate whether the process of boiling an egg was understood as physical change by a sample of grade 9 (15 years old) and grade 11 (17 years old) Portuguese students and to analyse whether the nature of inadequate conceptions held by students in the elementary course differed from those in the advanced course. All students had been exposed to formal instruction in the topic of chemical reactions but in no case did the teachers explore the example under study.

Insights from the analysis may help science teachers to look at this experiment through the students' eyes and provide them with useful cues on how to explore alternative ways of teaching.

Research Procedures

The design adopted involved two closely related steps. In step 1, 30 students (15 of each grade level) were individually interviewed in order to build up conceptual inventories (Erickson, 1979) about the process involved when boiling an egg.

Interviews (40min) were based on an experimental task consisting of boiling an egg (without cracking) in a saucepan. Typical questions asked of the students were: 'What happens to the egg?' or 'Why does it become hard?'

In step 2, main conceptions identified in the interviews were used to design two true/false questions subsequently administered to a representative sample of 262 grade 9 students and 186 grade 11 students (drawn from mixed ability classes from schools located in urban areas of Portugal). The two items (see below) were false as no student in step 1 gave the acceptable answer previously defined by their chemistry teacher. Acceptable answers for grade 9 students considered that the process of boiling an egg involves separation/reorganization of atoms in the egg with new substances being formed in the boiled egg. Energy of the raw egg molecules and heat energy supplied during boiling are transformed so that energy of the molecules in the boiled egg is greater. For grade 11, teachers expected that students would be able to use a formal model of chemical reaction, i.e bond breaking...
TABLE 1

Percentage of Responses
True (T) and Don't Know (DK)

<table>
<thead>
<tr>
<th>Item</th>
<th>Grade 9 N=262</th>
<th>Grade 11 N=186</th>
<th>Average N=448</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(T) 66.2</td>
<td>(T) 49.7</td>
<td>(T) 59.3</td>
</tr>
<tr>
<td></td>
<td>(DK) 10.0</td>
<td>(DK) 10.7</td>
<td>(DK) 10.3</td>
</tr>
<tr>
<td>B</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(T) 56.5</td>
<td>(T) 62.9</td>
<td>(T) 59.2</td>
</tr>
<tr>
<td></td>
<td>(DK) 21.8</td>
<td>(DK) 11.3</td>
<td>(DK) 17.4</td>
</tr>
</tbody>
</table>

Results
Roughly 60% of the students (step 2) agree with explanations not involving modifications in the nature of the substances composing the initial system (raw egg) and therefore were consistent with an understanding of the chemical reaction, raw egg — boiled egg, in terms of a physical change. The extent of the inadequate ideas held by students in step 2 is presented in Table 1. The data shows that the two mechanistic models tested, ie molecular packing as a function of either particle size (item A) or increase of 'bonding' forces (item B) were held by pupils from both grade levels hence suggesting the persistence of these alternative ideas. For each grade level there was a substantial percentage of DK responses, specially for item B. Only a few answers were obtained for 'Other', some of which rendering problematic the content analysis.

(a) Molecular packing and particle size
In this case (item A) the process would involve a change in the size of individual particles themselves. Pupils probably transferred to the microscopic level knowledge of properties usually perceived at the macroscopic level (eg metals expand when they are heated) a tendency which has been acknowledged by some authors (Driver, 1985; Ben Zvi et al, 1986). Interview transcripts obtained in step 1 suggest that pupils' attempts to use models of particulate nature of matter were probably guided by perceptually dominant arguments of the kind: hard boiled egg (solid egg) — particles tighter — volume of the egg is the same — size of particles increases. For example:

... when we heat the egg the particles become bigger ... the size (of the particles) increases and they become tighter (in the boiled egg) ... you see the egg is now harder; it is more solid (grade 9)

Such local reasoning is consistent with ideas of conservation of substance described in the literature (Anderson, 1986; Méheut et al, 1985).

(b) Molecular packing and 'bonding' forces
Some pupils (item B) explained the reaction as a direct result of the heat energy transferred to the system. This transfer would increase the intensity of the bonding forces between the molecules in the raw egg so they become more packed. It should be noted that the nature of the particles would remain unchanged in both the raw egg and the boiled egg. This could imply some sort of packing at the microscopic level. Typical responses given in step 1 are illustrated by the following transcript:

... we heat the egg and it becomes solid ... when it's boiled the molecules are stronger; you know, the bonds between the molecules are stronger (grade 11)

This mechanistic model was slightly more sophisticated than the previous one (item A) as students were somehow able to appreciate, the role of intermolecular (though inadequate) attributes to explain the 'physical change'. This probably explains the positive shift observed for grade 11 students. These students were not able to appreciate the difference between force and energy and its implications at the intermolecular level.

This confusion, which has been reported in other contexts (Brook et al, 1984) seems to be an important barrier to proper understanding of the chemical change under study. In this case solids
would have more energy than liquids (irrespective of temperature) simply because in the former particles are more packed, i.e. 'more packed' means 'more energy'. For example:

... this one (the boiled egg) takes in heat and it's harder ... you see the energy between the atoms of the solid is greater than the energy of the liquid (Grade 11)

Thus the change liquid — solid would be compatible with an endothermic process.

**Discussion**

Although experiments are indispensable tools in chemistry teaching, there is a need to be more critical about the sort of experiments we use and how they are used. We should perhaps re-examine the criteria used to choose some experiments we use and how they are used. We should perhaps re-examine the criteria used to choose some experiments proposed to pupils in our teaching, in particular the ones which have a perceptually obvious focus of attention. Familiarity with an event may not be the main criteria to select experiments in science lessons when perceptual aspects of the task may overrule conceptual dominant reasoning.

Clearly teachers should be more aware of the nature and role played by alternative ideas held by students about chemical change, both in structural and energetic terms (Martins & Cachapuz, 1990). In this investigation it became apparent how inadequate ideas about structural arrangements in solids and liquids which were earlier introduced in junior high school influenced further understanding of a chemical reaction. These inadequate ideas may often be used in a consistent and logical (though incorrect) way and are usually quite resistant to change as illustrated in this report for students from grades 9 and 11. Alternative ideas such as those identified in this study reflect how meaning was constructed by students and thus may be explored as inputs to help teachers to design appropriate diagnostic questions. For example, to challenge the idea referred to above that 'the energy of solids would be greater than the energy of liquids', teachers may find it useful to discuss this argument with pupils when the white (of a broken egg) is frozen. Furthermore they may also discuss whether the term egg used to name both the initial and the final systems implies the idea of conservation of substance.

Since for middle school students egg chemistry is beyond their level of comprehension, teachers should base alternative explanations exploring differences between directly perceived properties in both the initial and final systems, namely taste. For grade 11 students, teachers may go a bit further and explore elemental aspects of egg chemistry. For example, they may explain why cooked eggs present sometimes a dark green deposit (iron sulfide) as a result of a chemical reaction between iron (from the yolk) and hydrogen sulfide formed when proteins in the white are decomposed by heating (rinsing with cold water prevents the formation of iron sulfide). This will help students to adequately contextualize the process of boiling an egg in chemistry terms and to establish useful content bridges with the Biology course.

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A Unique Indonesian Program for In-Service Education

by Euwe van den Berg

Introduction

Indonesia is a large archipelago of about 13,000 islands stretched for some 6000km along the equator. It has a population of about 180 million people spread over more than 1000 of these islands, which together cover a land area of about 2 million square kilometers (800,000 square miles).

At independence Indonesia inherited a very small and underdeveloped educational system and a literacy rate of only 20% (the Philippines' literacy rate at independence was 80%). Rapid growth in enrolments followed independence to accommodate an ever larger proportion of a rapidly growing population.

At present elementary education has participation rates of nearly 100% while junior secondary education enrollment rates are about 60% (up from less than 20% in the 1970s!). The average class size is about 45 students.

School facilities were much improved during the 1980s. Most state schools acquired some new classrooms and a laboratory with equipment. As in other countries quite a few schools rarely use the equipment. Private schools often have little equipment, no laboratory, and few books.

As in other countries, the explosion in enrolments has caused serious quality problems. Classroom teaching is still too much 'chalk and talk' resulting in too little student activity other than listening and writing (Beeby, 1979; van den Berg & Lunetta, 1984). Such practices still continue, amongst others because of the shortage of textbooks.

Many books were printed in the 1970s, but two curriculum changes in the 1980s have rendered earlier books out of date. In many private schools only 4 or 5 students per class of 45 might have physics books, thus forcing teachers to spend much time dictating.

The Intensive In/On Service Program, 1979 - present

Since the introduction of a new science curriculum in 1975 the Department of Education and Culture had been active in organizing in-service training. However, after some years it was felt that brief 2 or 3 week courses were useless. Thus in 1979 the Department embarked on a new ambitious program of in- and on- service training with support from some international organizations (Pietersz, 1982).

The major purpose of the program is to change the classroom learning from passive listening and writing to active experimenting and thinking. While this is a rather common goal for in-service training, the sheer scale of the program and the multivarious conditions under which it has to operate are unique.

The program started with the selection and training of outstanding teachers who were to become in-service instructors. Then the worksheets were written, based on the national science textbooks. As curriculum authority resides in another directorate-general-level unit of the Department of Education and Culture, one had to go with the existing textbooks and syllabi. The worksheets simply tried to teach the textbook concepts through active experimentation by students, hoping that along the way they would pick up process skills.

The instructors or 'master teachers' then started to train teachers with a very weak science background and almost zero lab experience, to use the worksheets properly. The training pattern followed at the start of the project was the following:

- At the beginning of a semester teachers participate in a two week, full-time, in-service training where they themselves work through the worksheet activities under the guidance of a master teacher and with occasional aid of a subject matter consultant.
- Then the teachers go back to their schools to try out the materials while the master teacher travels around to observe their teaching. During this so called 'on-service' part of the training teachers meet once a week (initially Saturdays) to discuss their experiences.
- After 5 weeks of on-service the participants come together again for a week to evaluate their experience and try out the worksheets to be used in the next 5 week period. Another 5 week cycle of on-the-job training follows.

Three such 6 week cycles constitute the program.

Evaluation

By about 1984 the organizers had established a national network with training centers and trainers (master teachers) in 18 out of the 27 provinces, and trained teachers in almost every county of those provinces. During 1985 and 1989 trips to some remote areas, I ran into participants of the
program in almost every town. This is a tremendous achievement in a developing country with so many islands and weaknesses in infrastructure, communications and bureaucracy. Many industrial nations would have great difficulty in establishing a similar network in spite of easier communications, more efficient bureaucracies and more funding.

The network seems to function surprisingly well and appears to be able to overcome all the logistic obstacles involved in inter-island communication. Commitment of both staff and participants is high.

Activities have expanded very rapidly. An evaluation study was carried out in 1984 (Eggleston, Kertiasa, Nasoeion, Sukarno, Wilardjo), using interaction analysis to assess teacher and student behavior and group practical tasks to assess students' ability to conduct simple investigations. The study was executed in two rural provinces and in the two largest urban areas of Indonesia.

Observation of teacher and student behavior was done using a slightly modified version of Eggleston's Science Teaching Observation Schedule (STOS). STOS was developed by Eggleston, Galton, and Jones (1975) and used in studies in the United Kingdom, Canada and Australia (Eggleston, 1983). Results indicated significant shifts in teacher and student behaviors, especially in the rural areas.

In three out of the four areas researched, project trained teachers showed a larger number and variety of intellectual transactions in science lessons than teachers who had not yet participated in the training. There was more 'teacher talk' and a greater proportion of that in the higher intellectual demand categories, with a substantial reduction in teacher's statements of facts. (In STOS 'teacher talk' is defined as intellectual transactions requiring student responses, lecturing is not counted as teacher talk.) There was also more

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pupil talk, about twice as much as in classrooms of non-participants, and a
substantial shift to higher intellectual demand categories in the rural areas. In
urban areas the project had produced less or even no change, presumably
because (amongst others) urban teachers are more likely to have second
and third jobs and thus are less likely to implement time consuming new
practical methods and some urban teachers and students already showed
the behaviors promoted in the in-service program.

The group practical tasks required
groups of students to solve novel
problems using experiments. Trained
observers attended and scored their
performance according to
pre-established criteria. The tasks were
administered to groups of
teacher-selected students from
classrooms of participants and
non-participants. Results showed
significant differences between students
of program participants and
non-participants (physics scores
doubled!), the former performing
considerably better.

Studies like this are subject to many
unavoidable methodological problems
in spite of careful planning. For
example sampling of schools and
students was not random. Most of the
observers used were trainers rather than
objective outsiders. Differences in
educational background and experience
of program participants and
non-participants (planned and
unplanned bias in the selection of
program participants) could account for
observed differences as well. However,
most accounts of outsiders visiting
classrooms of participants confirm the
changes observed in the study. It seems
that the program does have a major
impact on teacher and student behavior
and achievement, especially in the rural
areas (where 80% of the population
lives). Such positive outcomes are
unusual in research on outcomes of
in-service training. Major differences
with well known in-service studies in
industrial countries seem to be

- the 'on' service component
- the well focused character of the
training (clear and specific in its goals,
methods, and materials)

- the very low starting level of
participants (abundant room for
improvement)
- a less individualistic and more
cooperative attitude of Indonesian
teachers as compared to their
colleagues in western countries

Local Networks
As it was too expensive to train all
science teachers in Indonesia using the
above method, a cheaper version of the
project was developed and started
operating around 1983/4. Local
training groups were established under
the guidance of graduates of the
in/on-service described above. Such
groups meet one day a week to discuss
the science lessons and activities for
the following week. Initially the
meetings focused on the worksheets.
However, now meetings might also
include discussions of test items,
subject matter to be taught, and other
problems faced in schools and
classrooms. Participants are provided
with free materials. These local
training groups also showed gains on a
number of categories in the study
describe above. Teachers from private
schools participate in these groups
along with teachers of state schools.
Private school teachers have to pay a
fee (to cover cost of food but the
arrangement may differ depending on
the region).

Participation of teachers in these
groups is voluntary, however due to
cultural and bureaucratic reasons
government invitations to participate
are rarely declined. That is certainly an
advantage, without that feeling of
compulsion, busy teachers might not

In almost every major town I have
visited on the main island of Java as
well as other islands including some
remote islands, thesecher groups are
meeting.

Reactions of participants vary.
Graduates of our teacher education
program who have participated in such
in-service groups usually found the
network support helpful in educational
matters and teaching methods but less
so on help with subject matter.
Participation in the group can greatly
help new teachers during their first
years of teaching. On the other hand,
subject matter mastery and laboratory
skills of many group leaders are
insufficient. The Ministry of Education
is working hard on improving the
quality of the national and local
in-service trainers and leaders. Many
leaders have been sent abroad for
further training in Graduate Diploma
and Masters programs in Australia and
UK. Annual national training courses
are organized for local group leaders.

Problems
The worksheets used in the projects
constitute the basis for an activity
oriented approach to science teaching
rather than a chalk-talk-textbook
approach. These worksheets show a lot
of creativity and they are interesting to
students. However, essential steps for
the acquisition of concepts are often
lacking and opportunities for providing
experiences to exercise process skills
are often not exploited. Lab manuals
and worksheets from many parts of the
world including the USA and college
level labs show similar weaknesses
(Hofstein and Lunetta, 1982).

Another problem concerns the structure
of educational incentives rather than
the program itself. Teaching activity
(lab) centered lessons in a proper way
requires a lot of extra preparation. At
present such extra efforts are not
rewarded, neither by extra benefits, nor
by a reduction in teaching load or
appointment of lab assistants.

Considering the low standard of living
in Indonesia and the fact that most
teachers are teaching at other schools
or private lessons in their free hours
(total loads of 40 periods a week are
not at all exceptional, occasionally I
have met teachers with loads of over
50 periods), the results of the
in-service program may quickly fade
away. Many (or most?) program
participants continue the laboratory
part of their courses after having
graduated from the in-service program.

Observers have noted clear differences
between schools with very supportive
principals and schools with 'neutral'
principals.

Yet another structural weakness
concerns the national curriculum. For
example, junior high school students
take about 15 different subjects (about
35 periods a week). At each grade level they get 2 hours of Physics and 2 hours of Biology. Using the activity oriented approach, teachers feel they cannot complete the ambitious syllabus. Until 1984 they could still use some hours reserved for skill education. With the introduction of yet another new subject this opportunity disappeared.

**Conclusion**

Indonesia has built a unique network for in-service training. The impact of the program on actual classroom teaching is difficult to assess and certainly not yet what was intended. However, the network could be a major asset in:

- induction of new teachers (assistance by peers)
- implementation of new policies (communication)
- sharing of equipment between schools
- educational change

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*Photo: 300 top science students from 52 countries attending the 1992 London International Youth Science Forum*
The textbook is the principal foundation on which most courses of instruction are based. It is still by far the cheapest form in which to encapsulate large amounts of information in a way that makes it readily accessible to large numbers of individual students. French (1985) stated that “the printed word is one of the richest and most precious forms of human communication and if we can teach pupils to read intelligently then we are performing a valuable function.”

The objectives of teaching primary science are clearly stated in the core curriculum, together with the preamble: That provided appropriate equipment and materials which the child may manipulate and experiment with, in a suitable social interaction, science education at primary school should enable the Nigerian child to:

- observe and explore his environment
- develop basic science process skills
- develop functional knowledge of science concepts and principles
- explain simple natural phenomena
- develop scientific attitudes including curiosity, critical reflection and objectivity
- apply skills and knowledge gained through science to solving everyday problems in his environment
- develop functional awareness of and sensitivity to the orderliness and beauty of nature

It is noteworthy that cognizance is taken of the fact that the child must of necessity be provided with materials for science, which are suitable for social interaction and are specifically mentioned. The interplay between these and the acquisition of scientific knowledge by the primary school child must be explored for effective primary science instruction. Also the National Policy on Education identifies the laying of a sound basis for scientific and reflective thinking as one of its cardinal objectives.

The problem

Basically, national curricula are intended to achieve some measure of harmonisation among the states of Nigeria. In the primary science curriculum, provisions are made for materials for teaching specific topics or concepts. These guide teachers from varying localities as they adapt them to fit their local environments.

Seven different primary science programs formed the basis for the formulation of the national curriculum. It is therefore possible that certain factors peculiar to some states may have been incorporated into the document. Furthermore, at all levels of formal school education, science should be treated as a way of life... a way of thinking, of behaving, indeed a dimension of self and the lifestyle of the individual (Asun, 1987).

Since human variables in science instruction should be considered, it is important that experts in the teaching of science to children should be consulted for their views on identified instructional problems. It is against this background that answers were sought to several questions:

Method

A questionnaire was designed to elicit information about:

- qualifications and teaching experiences of respondents
- competences in textbook writing
- important cultural factors that could promote or inhibit adopting a text for use in a locality

- learning patterns among Nigerian children
- suggestions for improving books available in the market
- degree of support for teachers’ guide and pupils’ workbook
- suggestions for organising the content of the proposed book

The instrument was validated by science educators at Ahmadu Bello University. Using a test-retest technique, a reliability coefficient of 0.85 was obtained. Copies of the questionnaire were sent to science teachers, randomly selected from the list of members of the STAN primary science panel from 1984-88, which included teachers from all levels of the education system. 184 of the 200 teachers selected completed and returned the questionnaire (4 poorly completed returns were rejected).

Results

1. Qualifications of respondents

Grade II Teachers Certificate (55); NCE (45); BEd or BSc(Ed) (60); MEd (15); PhD (5). Years of teaching experience ranged from 8 to 25 years with an average of 12 years. All respondents had taught primary science at various levels. About 10% had written primary science instructional materials in one form or another.

2. What cultural factors should be considered when writing a primary science series for Nigerian children?

Use of local examples: this will vary from one locality to the other, given the size and other environmental conditions of the country.

Local alternatives for scientific terminology: names could be retained but pronounced and spelt in local language (eg rula for ruler).
Locally practised science and technology should be identified and included where applicable and where possible.

Use of local language: Books 1-3 should have English, Igbo, Hausa and Yoruba versions as suggested in the National Policy on Education.

Climatic factors and their effect as to the variability of plants and animals found in each geographic zone should be reflected in the book: different areas have different plants and animals inhabiting them.

Taboos and superstitious beliefs, where identified, could be explained so as to redirect the child's belief and ideas; this could be done by carefully structured lesson plans and effective teaching.

Local occupations, tools and agricultural products should be borne in mind as they vary from one locality to another; these are reflected in the curriculum under technology.

Variations in local buildings should be reflected in the texts: shapes and structures vary from one locality to another.

Co-operative attitude of communities in solving common problems should be reflected in the class activities: this could be used effectively in practical work by grouping the pupils.

3. What learning patterns are common in Nigerian children?

Although guided enquiry has been introduced in the teaching of primary science, together with process skills, most respondents observed that the Nigerian child learns mainly by memorisation. Most attributed this to our mode of evaluation which encourages recall. Hence children tend to memorise to pass examinations.

4. What specific changes or improvements are advocated for a new primary science series?

- More uses of common and local examples should be adopted.
- Guided enquiry and problem solving should dominate content and activities.
- The modular arrangement should be adopted.
- Pictorial illustrations should be self-explanatory. They may not necessarily be in colour to reduce cost.

- All evaluation should be incorporated in the textbook.
- All materials should be locally or readily available.
- The entry behaviour of pupils should set the level of learning experiences. Writers may like to carry out some studies on the readiness of pupils.
- Some activities should be open-ended involving designing, drawing and constructing materials.

5. What specific new ideas are recommended in science curriculum reforms?

- Evaluation of draft should be carried out before embarking on publication.
- There should be a set time limit for the review of the text.
- Emphases should be focused on the improvement of the quality of life.
- Use of games is lacking and should be included.
- Evaluation should involve the cognitive, affective and psychomotor domains, not cognitive only.

6. How should the instructional content of the book be organised?

- Workbooks should be avoided. They are expensive, pupils do not buy them and teachers rarely use them.
- There should be enough questions at the end of the book to replace workbooks.
- Units should adopt a modular approach, with the headings: (1) introduction; (2) objectives; (3) content; (4) summary; (5) exercises.

Each unit should be linked to others for readability and continuity. The teachers' guide should not be written because it discourages initiative.

Discussion

The objective of this study is to ensure that experts in the field supply information useful in guiding the writing of primary science textbooks so that they meet the needs of society. Although parents and the general public could make some input, expert science teachers are in a better position to provide vital information. In a multicultural, multilingual, plural society like Nigeria, instructional materials for early childhood education should be written with a lot of care – differences within society should be closely examined, and efforts should be made to incorporate the most profitable cultural attributes within the learning program.

The responses clearly show that science educators are concerned about primary science. Much has been said about primary education in general and primary science in particular. For example, Hollins (1985) recognised the need to consider cultural differences in a plural society; Bajah (1990) spoke about the documentation of superstitious beliefs with a view to correcting wrong impressions in young minds. In Kano (1990), members of the primary science committee called for a modular approach in the organisation and teaching of primary science.

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Recommendations
1. Efforts must be made to identify what are regarded as appropriate equipment and materials, as well as suitable learning environments with a view to recommending them for use.
2. Efforts should be made to have the books for the first three years in English, Igbo, Yoruba and Hausa versions.
3. Continuous assessment should be encouraged. Questions that could lead to discussions, design and production of materials should be given prominence.
4. A workbook should be discouraged, but a teachers' guide should be considered in view of the large number of unqualified teachers that teach primary science.
5. The life of a primary school textbook has been set at six years. Writers of primary science books must ensure that the books are so current that they may not need any review during this period.
6. The modular approach should be adopted. Each module should have a number of units. Different writers should decide on the format for their units.

The task of producing a standard set of primary science series is not an easy one in a plural society with pupils of varying educational backgrounds. The Nigerian child needs to be nurtured and exposed to the attributes and products of science so as to meet the demands of the technological age.

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25
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AIMS
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- Promote the value of science experiences for young children throughout the world.
- Facilitate professional development opportunities for teachers by including sessions on primary science and technology in regional and international conferences.

ACTIVITIES
The Stepping into Science Team is actively involved in a number of projects and activities including:

- Publishing STEPS, the Stepping into Science Project Newsletter. This newsletter contains ideas for class activities at various levels in primary/elementary schools, activities for children to do at home, comments by network members on issues, examples of children's work, lists of helpful resources and contacts. ICASE acknowledges the contribution of Philip Harris in sponsoring STEPS.

- Contributing articles and ideas for the Primary Science Section in Science Education International, the ICASE quarterly journal.

- Compiling ideas and activities for inclusion in a series of sourcebooks on the teaching of primary/elementary science and technology.

- Coordinating a scheme to encourage children to participate in science and technology activities. Certificates of Participation have been produced, and are available for schools to use in rewarding students as they complete a number of activities. Certificates are colour coded in seven different colours, so that they can be used to acknowledge progress in science from early to advanced levels within primary/elementary schools. ICASE is grateful to BP (Oman) for sponsoring this scheme.

- Organising Stepping into Science workshops and displays of children's work at national, regional and international conferences.

FOR MORE INFORMATION
Contact the Project Officer:
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STS-Environment-Problem Solving

by William Soprovich

This article is reprinted from 'Sustainable Development for a New World Agenda: Proceedings of a Conference, October 17-20, 1990' edited by John E Penick & John R Stiles, and published by STAM/CASE/ICASE.

Background

Approximately four years ago, a Science Committee for years 5-9 was examining what emphases should be placed upon various goals for science education in grades 5-9. Emphases upon career development, using curriculum to increase the number of women in the physical sciences, problem solving, and scientific literacy (Roberts, 1983) (often undefined) were prevalent. In addition, a renewed emphasis has been placed by the National Science Teachers Association (NSTA) and the Science Council of Canada upon the inclusion of Science Technology Society (STS) in science programs. The Science Council of Canada report had recommended that a percentage of time be allotted to STS from K-12.

Unwilling to simply begin another crusade saying "stop doing Y and begin doing X" recommending a time allotment for STS without removing anything from the curriculum, the important question appeared to be that of defining the nature of STS and its potential relationship to the remaining part of the curriculum and emphases. Environmental literacy, indicated by many to be of critical concern to many, was represented at least partially by an ecosystem theme in K-9. Science processes, as part (or one kind) of problem solving was also a part of the science curriculum. Finally, the Science Committee did attempt to provide for a certain amount of time for STS, examining relationships to the total balance in curriculum with a resulting change in some of the topics and emphases.

STS: general concepts and some considerations

Including aspects of the nature of science-technology-societal interactions in the science curriculum is not novel. However, past efforts have been incomplete. During the 50's and 60's, for example, the principles of redox were applied to processes used in the iron ore industry by describing the Bessemer process. Similarly, the principle of heat exchange was described in the refrigerator as a scientific-technological interaction. As a result of the activities, Pella (1974), Aikenhead (1974), and many educators gave a more complete description of these interactions and their potential in science education became apparent. A brief overview of their major ideas included:

- Technological aspects of science are a link between the scientist and the non-scientist.
- The advancement of science and technology initiates social, economic and political changes.
- Science is an internally regulated social institution (includes knowledge of natural phenomena, processes, and a set of values).
- The changes in society resulting from advanced science and technology may produce social and political problems which must be managed, in a democracy, by appropriate social and political processes.

These ideas, which suggest at least some cooperation between disciplines such as science and social studies, were included in a series of concepts (objectives) developed by the New York State Education Department (1985).

The interdisciplinary nature of STS has a critical implication for decisions about the design of the science program (and possibly other programs). At one extreme, for example, does one design the science 5-8 program, using problems and major themes such as transportation to tie together the important science concepts and processes, while at the other extreme use a more science-oriented base and build interdisciplinary activities (short and long term) which could be related to use the latter approach as one with more familiarity to teachers and one which would still allow for the implementation of STS through inservice and pre-training work with specific case studies and other activities. Although a long term goal, it was considered important that many disciplines and teachers became a part of a new approach.

A second problem for the design of the curriculum lay in the definition of the nature of science and recent criticisms of the methods used by science programs to develop these understandings in children. For example, Hodson (1988) claims that "In relying heavily on inductive references, discovery learning methods present a distorted and inadequate view of scientific methodology ... For children to discover anything, they need a prior conceptual knowledge." Fleming, as a result of research with 16-18 year olds, concluded:

- All subjects used knowledge about science and scientists when reasoning about the issues. Most of the knowledge was incorrect. For example (a) science was seen as the creator of truth; scientists were the custodians of
this truth, (b) scientists were seen as concerned with progress but never were concerned with human issues, (c) subjects are thoroughly confused by the concept of a scientific fact.

- Socio-scientific issues were far more 'socio' than 'scientific' (Fleming, 1987). Again, the importance of 'integration or correlation' between science and social studies is implied. In addition, the questions of age levels and ways to develop a better understanding of the nature of science should be considered. Selley (1989), who examined this development in British science textbooks for ages 11-13, considered it to be premature because these students tend to be egocentric and up to the age of 12 seem not to be bothered by discrepancies between their own and other results. He suggested delay to the 13-16 age range and having students engage in scientific model-building (Nussbaum & Novick, 1981). Solomon suggested that attempts to deal with the philosophy of science be delayed to the 6th Form in order to be most useful and effective (Solomon, 1986). Some implications, then, for the design of STS within the curriculum include:

- At the elementary level, where the conceptual structure is simple, an integrated approach emphasising science processes would be valid. Simple hypothesis testing and even hypothesis generation could occur at the upper elementary and later levels (Pella, 1966; Quinn & George, 1975).

- Building of scientific models at the upper middle year levels with short term activities or discussions which develop such concepts as "chance" in scientific discovery.

- A course or program, for ages 17-18, which integrates knowledge and skills from a variety of disciplines (as suggested by Solomon's SISCON project). The difficulty with this approach would be its lack of availability to many students in an already overcrowded curriculum. A better approach, in terms of student availability, would be that of attempting to design a program for Grade 10 and to place STS oriented units in most other units.

- Laboratory activities are good for developing scientific knowledge and processes and laboratory skills. Additional active learning experiences will have to be available. For example, computer-assisted learning for work on hypothesis formation and testing, and project work which provides the learner with opportunities to choose an investigation and the investigation strategies, are possibilities.

**STS and problem solving/decision making**

Terms such as problem solving, decision making, critical thinking, and inquiry sometimes overlap in part of their definitions, may be narrow or wide according to the discipline or level, and can sometimes be confusing. At the elementary level, for example, Shaw (1977) defined problem solving skills to include the four integrated science processes of interpreting data, controlling variables, defining operationally, and formulating hypotheses (a somewhat limited operational definition). However, the science processes, including the simpler ones, are considered to be a good basis for contributing to the development of thinking skills. Although effectiveness of inquiry and activity oriented programs have been questioned in the past, recent analysis of studies have indicated success. Helgeson (1987), states "Clearly, inquiry experiences ... are effective in promoting problem solving and result in increased conceptual learning when content and science process instruction are integrated." In addition, problem solving behaviors are enhanced where students have some freedom of choice and control over events and can work in small groups. In addition to science oriented activities, consumer oriented testing such as comparing paper towels for absorbency and strength and the testing of simple paper or drinking straw bridges can be related to the nature of science and technology.

A more extensive model for problem solving/decision making was obtained from work by Zoller (1987) and Aikenhead (1974). Abilities to be developed in students include:

- Ability to look at a problem and its implications and recognise it as a problem.

**STS and environmental education**

Six out of ten Americans in 1982 believed that more good than harm has come from science and technology and that most of the economic and social problems that we face will eventually be solved by new technologies (Dissinger, 1986). Some would argue that this perception of science and technology is fortunate because of all the bad publicity found in the media. But, perhaps, even this perception has changed since the Chernobyl disaster. Although a negative impact upon students' perceptions of science and technology can be a concern, one of the issues is helping students to have a more balanced view of these interactions. Students should be helped to recognise that the use of an old technology or a change to a more
ecologically sound approach would be more appropriate, e.g. the experiences of the "green revolution" and its impact on rice growing in Indonesia.

Environmentally oriented topics provide major opportunities relating to STS. In Manitoba, approximately 20 percent of the program is oriented towards ecology and ecosystem concepts. In addition, such topics as soil and management, alternative forms of energy, and flight, from other disciplines increase the opportunity to provide an environmental-STS orientation.

A model for environmental education, which can provide a general framework for the Manitoba K-12 curriculum, is that proposed by Project Synthesis (Volk, 1984) and developed more fully in the UNESCO Environmental Series (Hungerford & Ramsey, 1989). The elements of the proposed model include:

Level 1: Ecological foundation knowledge
Permits the student to make ecologically sound decisions. Includes energy transfer and succession, limiting factors and ecosystems, population dynamics, and man as a variable.

Level 2: Conceptual awareness - issues and values
Develops an awareness of how actions may influence the relationship between quality of life and quality of the environment, and also how these actions result in environmental issues which must be resolved. An example of objectives in this area is "Describe the significant role that the individual and his/her family play in contributing directly and indirectly to the environmental quality."

Level 3: Investigation and evaluation
Provides for development of the knowledge and skills necessary to permit receivers to investigate environmental issues and evaluate alternative solutions.

Level 4: Environmental action skills
Development of the knowledge and skills to take positive environmental action.

Considerable overlap between the environmental model and goals of science education and STS occur. The development of science process and inquiry skills or the nature of science are obvious examples.

A recent report on the CBC program "Quirks and Quarks" stated that a northeastern US consortium had requested a quantity of electrical power from Quebec. When the powers that be started to discuss additional facilities however, the consortium indicated that all the power must be obtained through the method of conservation, an interesting, positive alternative or trade-off relative to sustainable development. The province of Manitoba has recently proposed some principles of sustainable development and has been receiving a great deal of public input into examining objectives and policies relative to water, soil and land use, and forestry. The response has again illustrated the vast differences in opinion and the difficulty of reconciling different value systems, particularly in the area of economics. Since an education component is one part of the strategy, it is hoped that new materials with some local slant will develop. This is beginning to occur with the development of case study materials in the Lake Dauphin watershed which look at some positive alternatives for resolving major salinity problems.

A brief summary
Curriculum models, more so than scientific models, have the general difficulty that they are only a representation of reality. Apart from the significant needs within this model to fit some parts into the "paper" curriculum, to identify support materials already available and/or to develop additional materials, an additional question relates to implementation within the classroom. This involves teachers and the school support system. Bybee and Bonnsteller (1987), recently looked at implementing STS with the following teacher rating of concerns:

- economical (materials, facilities)
- personnel (teacher education, background, abilities)
- pedagogical (lack of available teaching techniques, new strategies, etc)
- social (public support, social awareness)
- psychological (negative attitudes towards change, lack of encouragement and support)
- political (acceptance at local and/or national level, administrative support)

It is likely that a similar situation exists in Manitoba, and thus, a need for long term support through a cooperative effort among provincial departments and faculties of education for the local school system.

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6-16 September 1993
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Science Across Europe: Key Issues for Society

Published by the Association for Science Education and supported by a grant from BP

Science across Europe is publishing a series of units on scientific issues and providing an associated database of participating schools.

Science across Europe provides a forum through which students may exchange facts and opinions with students in other countries.

Two books are now available - Acid rain over Europe and Using energy at home. Three are under development - Renewable energy, Drinking water, and What did you eat? , and more are planned for the future. Schools from Norway, Sweden, UK, Denmark, The Netherlands, Belgium, France, Luxembourg, Germany, Switzerland, Austria, Slovenia, Portugal, Spain, Gibraltar, Italy, Malta, Greece and Cyprus have already taken part in the project.

Each book includes an introduction to the project, maps, data and teachers' notes, as well as examples of the information exchanged between schools. The student pages are printed as copyright waived masters in ten language versions. Upon sending in a registration form, the project provides details of schools in other countries participating in the scheme. The teacher then selects schools who are listed as wishing to exchange information during the time specified, and whose age/ability is appropriate.

Books can be ordered for £19 each as follows. The price includes membership of the network, post and packing. Send order, specifying language edition required, with payment to:

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NEW ICASE PUBLICATION

Education in Science and Technology for Development

Perspectives for the 21st Century

Proceedings of
ASETT/ICASE Conference 91

Edited by
Judith Reay & June George

This new ICASE publication contains the papers presented at the ASETT/ICASE Caribbean Conference '91 organised by the Association for Science Education of Trinidad and Tobago (ASETT), 27-30 August 1991, at the University of the West Indies, St Agustine, Trinidad & Tobago. Papers are grouped in three sections.

The first section 'Issues in Education' includes papers which take a broad view of policies and practice. One paper urges teachers to question all 'knowledge'; another identifies a need for universities to articulate better with schools and with industry; another argues for much more attention to technology in schools.

The second section 'Curriculum and Educational Strategies' is closer to the classroom and spans primary through secondary to tertiary teaching.

The third section 'Science and Technology and Education' has more emphasis on science/technology, including contributions on topics as diverse as biotechnology, solar dryers, and a steel drum. The publication concludes with a set of resolutions arising from Conference '91.

Copies can be ordered from:

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ICASE is keen to arrange regional or world events for the benefit of member associations. If your association or organisation is interested in hosting an international seminar, workshop or conference, contact the Executive Secretary or your Regional Representative. To gain ICASE endorsement, the meeting must be international in nature, open to member associations, and, while all sectors of the science education community should be encouraged to participate, must be relevant to classroom teachers.

March 21 - April 2
Science Education in a National Curriculum: An International Symposium
Location: University of York, UK
Contact: Courses Department, The British Council, 10 Spring Gardens, London SW1A 2BN, UK
Topics include: building a national curriculum; new science curricula in secondary schools; styles of curriculum development; evaluation of science curricula; impact and research on developments in science curricula; student assessment; changing demands for staff development; links between industry and science education; the role of national and international agencies in science education.

March 25-30
Sixth International PATT Conference
Location: Motel Eindhoven, The Netherlands
Contact: dr Marc J de Vries, Pedagogical Technological College, PO Box 826, 5600 AV Eindhoven, The Netherlands, Fax 31-40-440045
The aim of this conference is to exchange ideas and information on theoretical and practical implications of the implementation of environmental issues in technology education according to the subthemes: (1) Pupils' attitudes towards technology and the environment; (2) Environmental issues in primary and secondary technology education; (3) Gender aspects of environmental issues in technology education; (4) Environmental issues in the education of technology teachers.

April 10-24
Edinburgh International Science Festival
Location: Edinburgh, UK
Contact: Edinburgh International Science Festival Ltd, 1 Broughton Market, Edinburgh EH3 6NU, UK
The program for the fifth Edinburgh Science Festival will span many themes ranging from the environment to space, and high technology to health but, perhaps most importantly, each of the 300 plus public events will explain -- in jargon free language -- how topical issues within each theme affect everyone. A major international conference focusing on initiatives taken by a wide variety of organisations, in many different countries, to improve communications between scientists, the media and the public will be one of the highlights.

April 12-16
Curriculum Reforms for the 21st Century Africa
Location: Mombasa Beach Hotel, Northern Main Island, Kenya
Contact: The Director, Centre for Curriculum Studies in Africa, PO Box 43844, Nairobi, Kenya
The Centre for Curriculum Studies in Africa announces an African Regional Conference on the topic 'Curriculum Reforms for the 21st Century Africa', sponsored by UNESCO. This conference will: (1) review current theories underlying curriculum development and their relevance to educational practices in the African region; (2) examine emerging models in curriculum design and development in the African region; (3) review innovations in curriculum activities in the African region; (4) examine new strategies in curriculum implementation in the African region; (5) examine the role of evaluation in curriculum design and development in the African region; and (6) identify research gaps in curriculum theories and practices with a view to establishing an African regional research capacity bank.

April 8-10
Building Bridges to Science
Location: King James Thistle Hotel, Edinburgh, UK
Contact: Sally Goodman or Brian Hamble, British Association, Fortress House, 23 Savile Row, London W1X 1AB, UK, Fax 071-734-1658
This British Association conference, sponsored by Glaxo, will bring together speakers from museums, science centres, science theatre, education and industry, to focus on ways of forging links between different areas of science communication which are consumer-led. Sessions will be devoted to international links in science awareness, the science-art divide in education, science 'advice centres', making links with industry, and bringing science to rural areas. The conference will give participants a chance to discuss new ways of bringing science to rural areas. The conference will give participants a chance to discuss new ways of bringing science to wider audiences across Europe and to see some of the projects in action.
April 21-25
International Conference on Geoscience Education and Training
Location: University of Southampton, UK
Contact: Mrs Esther Johnson, GEOED Conference Secretariat, Department of Geology, University of Southampton, Southampton S09 5NH, UK
The Association of Geoscientists for International Development (AGID) and the Commission on Geoscience Education and Training (COGEOED) of the International Union of Geological Sciences are convening this international conference with the support of ICASE. Themes include: geoscience education in schools; higher education; geoscience training for business, industry and public service; and public understanding of geoscience. The conference is open to all those with an interest in geoscience education and training - including practitioners and those involved in administration, course development, and the supply of resource materials.

June 27 - July 3
VII Pacific Science Inter-Congress
Location: Okinawa Convention Center, Okinawa, Japan
Contact: VII Pacific Science Inter-Congress, c/o Section of International Affairs, University of the Ryukyus, 1-Senbaru, Nishihara, Okinawa, 903-01, Japan
The Symposium will be organised around the theme The Pacific: Crossroads for Culture and Nature and subthemes (1) Cultural Interchange among Pacific Peoples; (2) Speciation, Dispersal and Conservation of Species in the Pacific; (3) Towards Appropriate Technologies and Policies for Development and for the Conservation of Natural Environments in the Pacific. Scientific sessions organised by the Scientific Committees of the Pacific Science Association focus on a range of science disciplines and issues, including Science Communication and Education.

July 5-9
CONASTA 42
Location: Sydney, Australia
Contact: Jenny Jones, Convener CONASTA 42, PO Box 787, Potts Point, NSW 2011, Australia
The Australian Science Teachers Association invites you to participate in the 42nd annual conference of the Association. The theme of 'Science – Teaching it Better!' aims to highlight the part that teachers can play in fostering in their students an interest in and understanding of science. Four subthemes will deal with both primary and secondary school issues: (1) Science updates - recent exciting developments and their impact; (2) Science education research - what it has to offer the classroom teacher; (3) Science teaching for effective learning - how do we engage minds in the classroom?; (4) National initiatives. The program includes theme lectures, interactive workshops, seminars, field workshops, 'wandertimes' and poster presentations. A comprehensive display of resources useful to science teachers will be presented by publishing, audiovisual, equipment and computing companies.

July 6-10
Project 2000+ International Forum
Location: Paris, France
Contact: Dr Jack Holbrook, ICASE Executive Secretary, Department of Curriculum Studies, University of Hong Kong, Hong Kong
This worldwide conference, organised by ICASE in conjunction with UNESCO and other international bodies is the second phase of the three phase Project 2000+. The theme of the forum addresses the issue of Scientific and Technological Literacy for All. Sessions will establish agendas for future action. Attendance will be by invitation only (500 participants). The forum plans to issue statements to affect political visibility for science and technology education for all as a requirement for national development, and provide a framework for major programs of action in science and technology education involving governments, IGOs and NGOs.

July 8-11
ASERA 93
Location: The University of New England, Lismore, NSW, Australia
Contact: Keith Skamp, Conference Convenor, ASERA 93, Centre for Education, UNE - Northern Rivers, PO Box 157, Lismore, NSW Australia, Fax 066-221-833
The Australasian Science Education Research Association (ASERA) invites all those with an interest in science education research, including primary and secondary teachers and teacher educators to participate in the 24th Annual Conference of ASERA.

July 28 - August 11
London International Youth Science Forum
Location: London, UK
Contact: LIYSF, PO Box 159, London SW10 9QX, UK
The Science Forum is the principal annual meeting in Britain of young scientists. Over three hundred students attend from some fifty nations to make this an international event of major significance. The program features lectures, seminars and demonstrations from leading scientific names, and an extensive range of visits to university and industrial research establishments.

August 15-20
34th IUPAC Congress
Location: Beijing, China
Contact: Prof Xinqi Song, Secretary-General of 34th IUPAC Congress, c/o Chinese Chemical Society, POB 2709, Beijing 100080, China, Fax 86-1-256-8157
The Congress is being organised by the Chinese Chemical Society, sponsored by the International Union of Pure and Applied Chemistry (IUPAC) and supported by a number of scientific organisations in China. The program features plenary lectures and invited lectures from key scientists and educators around the world, addressing the following topics: (1) life science and organic chemistry; (2) chemistry for a better environment and analytical chemistry; (3) chemistry of advanced materials and inorganic chemistry; (4) new polymer materials and macromolecular science; (5) petrochemistry.
fossil fuels chemistry and catalysts; (6) physical chemistry; (7) chemical information and computers in chemistry; and (8) popularisation and education of modern chemistry.

**September 6-16**

Science, technology and society – appropriate science education for the twenty first century

Location: Department of Educational Studies, University of Oxford, UK

Contact: Your local British Council office, or Courses Department, The British Council, 10 Spring Gardens, London SW1A 2BN, UK, Fax +44-71-389-4154

There are vacancies for 30 participants to focus on the following issues: (1) the nature of STS as education; (2) objectives and the evaluation of courses; (3) information knowledge and public understanding of science; (4) industry and STS; (5) STS in developing countries; (6) law, values and decisions about the environment; (7) new curriculum materials; and (8) teachers and in-service education. The seminar is intended for experienced science teachers, educationists, and government officials involved with curriculum planning and implementation and in-service work with teachers. The seminar fee, including accommodation, is £1440.

**September 11-14**

2nd European Conference on Research in Chemical Education

Location: Pisa, Italy

Contact: Dipartimento di Chimica e Chimica Industriale dell'Università di Pisa, via Risorgimento, 35, 56126 - Pisa, Italia, Fax 050-918-260

This conference aims to describe the state of chemical education research and to help chemists develop this research, and develop a European cooperation for the defense and promotion of didactics. Topics include representations and conceptions, evaluation, trends in didactics, problem solving, experimental teaching, computer assisted teaching, new technologies, and chemistry and the environment.

1994

**January**

ASE Annual Meeting

Location: UK

Contact: Annual Meeting Secretary, ASE Headquarters, College Lane, Hatfield AL10 9AA, UK

Full details of this large international event will be circulated in *Education in Science*, a journal of the Association for Science Education.

1995

**July 27 - August 10**

London International Youth Science Forum

Location: London, UK

Contact: LIYSF, PO Box 159, London SW10 9QX, UK

The Science Forum is the principal annual meeting in Britain of young scientists. Over three hundred students attend from some fifty nations to make this an international event of major significance. The program features lectures, seminars and demonstrations from leading scientific names, and an extensive range of visits to university and industrial research establishments.

**August 8-12**

13th International Conference on Chemical Education

Location: San Juan, Puerto Rico

Contact: Ram S Lamba, Chairman 13th ICCE, Inter American University of Puerto Rico, PO Box 191293, San Juan PR 00919-1293

This will be the first time that an ICCE meeting will have been held in the Caribbean Region. The objective of this conference is to bring together chemistry teachers from the pre-college and college levels to share ideas and learn from each other about innovations in the teaching and learning of chemistry. The theme is 'Chemistry: The Key to the Future'. The Conference will feature plenary lectures, symposia, lecture presentations, workshops, poster sessions and exhibitions. Scientists and science educators from around the world will report their work.

1994

**January**

ASE Annual Meeting

Location: UK

Contact: Annual Meeting Secretary, ASE Headquarters, College Lane, Hatfield AL10 9AA, UK

Full details of this large international event will be circulated in *Education in Science*, a journal of the Association for Science Education.

**July 26 - August 9**

London International Youth Science Forum

Location: London, UK

Contact: LIYSF, PO Box 159, London SW10 9QX, UK

The Science Forum is the principal annual meeting in Britain of young scientists. Over three hundred students attend from some fifty nations to make this an international event of major significance. The program features lectures, seminars and demonstrations from leading scientific names, and an extensive range of visits to university and industrial research establishments.

**August 25 - September 1**

International Conference on Industry-Education Initiatives in Chemistry

Location: University of York, UK

Contact: Miranda Mapleton, Chemical Industry Education Centre, Department of Chemistry, University of York, York YO1 5DD, UK, Fax +44-904-432516

This international conference is co-sponsored by the International Union of Pure and Applied Chemistry (IUPAC) Committee on Teaching of Chemistry, and the Royal Society of Chemistry Education Division and Industrial Division.
International Forum

Scientific and Technological Literacy for All

Phase 2 of Project 2000+

Paris, France
6-10 July 1993

This International Forum is the Second Phase of Project 2000+, an international project on scientific and technological literacy for all, which addresses the following 6 focus areas:

1. The nature of, and the need for scientific and technological literacy
2. Scientific and technological literacy for development
3. The teaching and learning environment for scientific and technological literacy
4. Teacher education and leadership for scientific and technological literacy
5. Assessment and evaluation for scientific and technological literacy
6. Non formal and informal development of scientific and technological literacy

Attendance will be by invitation only and limited to 500 participants representing:

- National EFA (Education For All) Groups
- National policy makers overseeing science and technology education
- INISTE centres
- Project coordinators and field workers for organisations
- Science and technology teacher associations
- Institutions, centres, universities and colleges involved in science and technology curricula, examinations and teacher education
- Science and technology out-of-school centres and organisations
- Non formal science and technology educational organisations
- Industrialists
- Persons from the mass media interested in Project 2000+

There will be a US$100 Registration Fee for each participant to help defray material costs. This will be payable to the Project 2000+ Secretariat on receiving the invitation. For further information, contact:

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This journal provides a means for associations, institutions, centres, foundations, companies and individuals concerned with science education, to share perspectives, concerns, ideas and information which will foster cooperative efforts to improve science education, and which will serve as a chronicle of the advancement of science education throughout the world.

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ICASE News
2
Feature Articles
3
Basic and applied science education in developing countries: trends and needs of the 21st century  JB Holbrook
Pre-college science education in Thailand  Naruemon Yutakom & J E Penick

Science Education Around the World
16
Research on Teaching and Learning
22
Evaluation of the educational benefit of a special exhibition at an interactive science centre  R A Schibeci

Science Teacher Education
26
The Iowa Chautauqua program: a model for in-service science education  R E Yager

Primary Science
28
Developing primary science in Pakistan  Hafiz M Iqbal

Science Technology Society
31
Young reporters for the environment  P Saugier

Resources
34
Calendar
36

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<table>
<thead>
<tr>
<th>Issue</th>
<th>Closing Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>March</td>
<td>1 February</td>
</tr>
<tr>
<td>June</td>
<td>1 May</td>
</tr>
<tr>
<td>September</td>
<td>1 August</td>
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Paris in summer ...

Sounds an ideal place to spend a few days for a holiday — but there won't be much spare time for ICASE delegates as they meet in Paris for the International Forum which marks the second phase of Project 2000+.

After many months of intensive planning and preparation, this key meeting is about to take place. Delegates from all over the world will converge on Paris to contribute, share and consider follow-up programs which will carry forward the challenge of scientific and technological literacy into the 21st century. The article by Dr Jack Holbrook in this issue provides readers with an overview of Project 2000+.

On Sunday 4th July, ICASE Executive Committee Members will meet. On Monday 5th July, ICASE will hold its 6th General Assembly (Part 1) in which all ICASE member associations, institutions and companies are invited to participate.

Part 1 will feature reports by ICASE officers and representatives as well as by ICASE member organisations. Part 2 of the General Assembly will be held on Sunday 11th July. During this time, the new ICASE Executive Committee will be elected, and Project 2000+ proposals will be considered.

Elections will be held for President, President Elect, and Regional Representatives for the following regions — Africa, Asia, Australasia & Pacific, Caribbean & South America, Europe, North America. Other appointments will be determined by the newly elected Executive Committee.

ICASE will be developing plans for projects and activities in the years ahead — no doubt these will be closely aligned with the need to move ahead supporting Phase 3 of Project 2000+.

Brenton Honeyman, Editor

This section provides news for the information of member associations, institutions, centres, foundations and companies. The Executive Committee encourages members to reproduce this section in journals and newsletters to communicate this information to as many as possible.

Technology Teaching Systems Ltd joins ICASE as a Company Member

ICASE welcomes Technology Teaching Systems Ltd as a Company Member.

TTS was formed eight years ago to supply materials for the rapidly expanding subject of technology in elementary schools but in the ensuing years their range of products was expanded to include science materials and equipment.

The company has always produced effective books and manuals to help teachers get the best from the equipment in terms of use and safety.

Recent export contracts emphasise that the company's experience is valued internationally as well as in the United Kingdom.

TTS can be contacted at the following address:

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Director
Technology Teaching Systems Ltd
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Holmewood
Chesterfield S42 5UY
UK
Tel: Chesterfield (0246) 850085
Fax: (0246) 855557

New Subscription Rates for Science Education International

Since the first issue of the ICASE Journal in March 1990, individuals and libraries have been subscribing to Science Education International.

Due to increasing production and postage costs, 1993 subscription rates have been increased to:

Individual
£10.00
US$17.50
A$22.00
CAN$20.00

Library
£20.00
US$35.00
A$44.00
CAN$40.00

Subscriptions can be sent to:
(cheques payable to "ICASE")
In US$: Prof John Penick
Centre for Science Education
University of Iowa, Iowa City
IA 52242, USA

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Basic and Applied Science Education in Developing Countries

Trends and Needs of the 21st Century

by Dr J B Holbrook
Executive Secretary, ICASE

'Science and technology will, according to forecasts, play a significant and dominant role in the 21st century. It is for this reason that this committee stressed the need to give science and technology a significant place within the Education for All program in Africa.'

(Extract from the advisory committee report on the renewal of science and technology education in Africa, 1992 Dakar)

'The World is at the threshold of a new century, with all its promise and possibilities. Today there is genuine progress toward peaceful detente and greater cooperation among nations. Today there are many useful scientific and cultural developments.

Therefore we participants in the World Conference on Education for All recognise that sound basic education is fundamental to the strengthening of higher levels of education and of scientific and technological literacy and capacity and thus to self-reliant development.

'BASIC education is the foundation for lifelong learning and human development on which countries may build systematically, further levels and types of education and training. In an increasingly scientific and technological world, scientific and technological literacy must form part of this foundation.'

(Short extracts from the World Declaration on Education for All, adopted at an international conference in Jomtien, Thailand, 1990)

'Never before in the history of the world has the quality of peoples' lives been tied so directly to science and technology . . . . Although there is no doubt about the linkage between overall economic well-being and scientific and technological development, the global impact on countries is often uneven and can result in negative consequences . . . . The problems need to be analysed globally and locally; they need to be dealt with internationally and at the national and local levels . . . . To accomplish this it is imperative that we have a world community of scientifically and technologically literate citizens.'

(Comments taken from a special UNESCO study by Bower, 1990, undertaken for the World Conference on Education for All)

But how is the world doing?

Coping with issues such as health, nutrition, environment, energy sources, finite resources, risk assessment, population control, global change and sustainable development at the local national and international levels is surely part of basic learning needs. These social issues need an increasing degree of scientific and technological literacy on the part of the populace for both the understanding and the decision-making involved to stimulate the necessary action. Yet it would appear that, in many countries, basic education in schools includes little that will help students achieve such literacy, or feel confident, either in applying their knowledge, or in dealing with societal issues and the need for a responsibility for action. It is also a sad fact that the ultimate decision makers, the politicians do not always have the background needed to receive and absorb the required scientific and technological advice necessary for them to function as efficient decision makers and administrators.

Scientific and technological 'illiteracy' is thus not only confined to the uneducated. There is much illiteracy even among scientists and science and technology educators, partly as a consequence of the high degree of specialisation encouraged in educational systems. A growing realisation is that 'science for the scientist' is not the only goal of science education. Furthermore, technology education is more than a craft course and involves processes as well as products.

Science and technology are part of the culture of societies and not to be conceived as purely mental and manipulative pursuits, isolated from issues pervading the society.

The need

Education faces a major challenge in learning how to help citizens cope with the 21st century and its increased use of technology. Technological development has been vast and swift and continues to increase at a rate that seems to be a never ending spiral. While the industrial revolution developed over an approximate fifty year period, the latter part of the 20th century has seen a rapid rush through the age of plastics, electronics, space, and into the computer age in about the same period of time. Our technological world is in a period of extensive change. Change for the future can be expected to be equally vast and today we no longer regard science fiction ideas as purely a matter of unattainable dreaming.

There is an urgent need to accept that science education and technology education are important for us all and that there are also differences between science and technology education which need to be recognised and understood. There is a need to rethink the objectives of science and technology teaching to give more serious consideration to the nature of science, science - technology links and the importance of technological skills in science courses. There is a further need to recognise that capability through technology
education is more than applied science and certainly far removed from the mere acquisition of technical skills.

Whilst a knowledge of science plays an important role in scientific and technological literacy, societal concerns rarely lend themselves to solely scientific or technological solutions. It is thus important that science and technology are taught in a societal context and students learn to cope with a decision making process in which a variety of factors (e.g., economic, environmental, ethical) may be more influential.

While conferences like the Education for All (WCEFA, 1990) grappled with the major concerns of worldwide education, the crucial role of scientific and technological education has been given far too little attention. Curriculum development often requires five to ten years preparation time and thus today, we begin to work on the pattern of education for the 21st century. If education in the schools is to have any hope of meeting such anticipated challenges for scientific and technological literacy, it is necessary, now, to establish goals, definitions, and strategies which will lead us into appropriate strategies for science and technology education suitable for societal needs in the next century.

**The issues**

In preparation for the 21st century, citizens need increased scientific and technological literacy. Not entirely clear is the exact nature of such literacy, how to achieve it, and what assessment mechanisms are most valid. Any discussion and the subsequent development of possible models for achieving scientific and technological literacy depend on research and development in this area around the world.

It would appear another issue is the degree to which science education should be directly relevant to the concerns and demands of the society and how far it should establish a groundwork for further learning, should a student wish to pursue a scientific career. A report commissioned by the World Bank in 1989 (The British Council, 1989) suggests that these approaches are somewhat in conflict and that presently far greater attention is given to science for continuation even at the primary level of education.

A further issue is the extent to which technology education should be an integral part of the formal school curriculum and taught separately from science. Whilst the two subject areas have unique components, there are also areas of great overlap and literacy issues between these subject areas, in which science tends to take on a societal slant, are often heavily interrelated. For developing countries, hard pressed to provide specialised facilities (such as that demanded by pure science), the attractiveness of a technology-science mix for all, may not only be desirable, but could prove doubly attractive when consideration is given to the less expensive, more flexible, facilities that would be required.

Appreciating, managing and having a sense of responsibility for the environment is another pressing issue in society and yet the natural world cannot be considered in isolation. This leads to education for sustainable development and how it can be achieved, given that the world is united in concerns such as global change, ozone layer depletion, the finiteness of energy reserves and the impact of deforestation. The environment has traditionally been taught within social science studies, but there is a growing recognition that a deeper understanding of the scientific and technological aspects are important and that science and technology education themes should take on an environmental outlook e.g., air, water, pollution, transport, energy sources, our health.

Education is important for all members of society and there is a growing need for the 21st century that there should be equal opportunity for all within education. Traditionally science education has attracted boys, either by offering choice at an age when boys are more easily motivated toward science, or by orientating the science topics for study so that they draw upon the experiences that favour boys. Yet where girls have studied science and technology, the research shows that they achieve equally as well as boys. Equity in science and technology education means recognising the importance of science and technology education for all citizens and then providing a wide range of experiences so that its appeal is appreciated by all.

**Project 2000**

Project 2000+ has been initiated by UNESCO and the International Council of Associations for Science Education (ICASE) to promote and to guide the implementation of a scientific and technological dimension of basic education in the context of education for all.

Project 2000+ recognizes the growing need for a greater scientifically and technologically literate society and seeks to:

- identify ways of promoting the development of scientific and technological literacy for all;
- put forward educational programs (both formal and non-formal) in such a way as to empower all to satisfy their basic needs and be productive in an increasingly technological society;
- provide guidelines for the continuous professional development of science and technology educators and leaders;
- encourage the formation of national task forces involving personnel from Government, Inter-Governmental Organizations (IGOs), and from Non-Governmental Organizations (NGOs) such as associations for science education – to initiate programs for greater scientific and technological literacy;
- support the development of a wide range of projects that aim to improve quality of life and productivity in society and that lead to promoting solidarity and cooperation in achieving scientific and technological literacy for all;
- support the evaluation of existing and projected programs to ensure scientific and technological literacy goals are being met.

**The educational directions to be clarified**

The project is designed to emphasise the growing need for a scientific and technologically literate public; to draw attention to the failure of societies to meet this need in their current educational programs, to examine ways of promoting the development of scientific and technological literacy for
all and to provide a foundation for the professional development of educators and leaders in the area of scientific and technological literacy. To meet these concerns, project 2000+ draws attention to more research development and dissemination studies in the following 6 focus areas:

1. The nature of, and the need for, scientific and technological literacy
   - **The meaning of scientific literacy, technological literacy and their interrelationship**
     This focuses on the need to examine the nature of scientific and technological literacy, the interdependence of science education and technology education, and the nature of technology education and the misconceptions held about it.
   - **A rationale for acquiring scientific and technological literacy**
     Scientific and technological literacy are essential for all to meet the challenge of:
     (i) the increasing impact of science and technology on people's lives, individually and in relation to society, as well as to their careers and quality of life
     (ii) the need for scientists, politicians and other key personnel to be scientifically and technologically literate as a basis for decision making, and for citizens to be able to participate meaningfully in science-related political issues
     (iii) the need for people to be functional in an increasingly technological environment; 'operacy' in relation to machines; appropriate societal behaviour for the benefit of the individual and society as a whole
     (iv) the need for a flexible work force which can be more effective if scientifically and technologically literate.
   - **Demystifying science and technology**
     To demystify science and technology, they must become accessible to all. Fears that this subject area is hard and remote must be overcome, preferably by initiating children, in appropriate ways, into science and technology concepts and processes at an early age.

2. Scientific and technological literacy for development

Areas for consideration here include national, social and economic development with particular reference to personal development, including human ethical values; science and technology education for women and girls; and quality of life issues such as sustainable development strategies and economic development opportunities for employment at local, regional and national levels.
In particular, this applies to

**Life-long scientific and technological literacy**
As science and technology develop, efforts have to be made to update the knowledge base needed to sustain scientific and technological literacy throughout life. Formal education systems must be complemented by efforts to promote public understanding, developing well thought out values and skills in decision making, based on science and technology. For this, use should be made of the media and other local community provisions.

**Research into scientific and technological literacy**
Serious research efforts must be directed to investigation of needed basic concepts; the knowledge base; processes necessary for scientific and technological literacy, including

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**ICASE AWARD SCHEME**

for outstanding contributions to international science education

Nominations for these awards must be forwarded by member associations of ICASE. For full details of how to forward nominations, contact the Executive Secretary below.

**ICASE Distinguished Service Award**
This award is made to individuals who have a career history of distinguished service to international science education through their involvement in the international activities of local, regional and global science education organisations

**ICASE Regional Service Award**
This award honours individuals who have made a significant contribution to international science education through their involvement in international activities at the local and regional levels

**ICASE Association Award**
This award recognises individuals who, within their science teacher association, have made a significant contribution to the international activity of their association

Contact Dr Jack Holbrook, Executive Secretary ICASE, Science & Technology Education Unit UNESCO, 7 place de Fontenoy, 75352 Paris, France

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problem solving, decision making, communication and risk assessment skills. Also, research should consider teacher education, learning environments, and career-related issues, all of which contribute to enhancing sustainable development. Further research should consider the place of population, health, energy and environmental issues in relation to scientific and technological literacy.

Case studies and examples of scientific and technological literacy in various settings

Descriptions of existing literacy programs are necessary to stimulate discussion, research, and action. Such examples are essential for preparing models for educational development.

3. The teaching and learning environment for scientific and technological literacy

The ultimate goal of scientific and technological literacy is to produce individuals who feel comfortable with, and who are capable of, learning and using science and technology and who are able to deal with change which accompanies developments in the field of technology. In developing this literacy, learning must focus on the individual. Such focus requires a carefully planned and creative learning environment. This includes taking account of:

- the role of the learner
- the role of the teacher
- the curriculum
- the physical environment where the learning takes place.

The desired role of the learner must be compatible with the nature of science and scientific and technological literacy and what is known about how people learn. To be useful, this role must be carefully described and documented.

Once the role of the learners is specified, a careful search of the literature should reveal appropriate teacher behaviour and actions which should lead to good learner performance. The object should be to develop appropriate teaching strategies for enhancing scientific and technological literacy. Since learners interact with the teacher in a context and physical locale, these too must be designed for compatibility with the ultimate goal — scientific and technological literacy.

4. Teacher Education and Leadership for Scientific and Technological Literacy

The teacher (or tutor/educator) is a key figure in the learning environment. Hence the teacher’s own education must be carefully planned to optimise the learning environment. Teachers (and others directing an environment for developing scientific and technological literacy) must consider and control the learning environment and their own behaviours. The following need consideration:

- necessary background knowledge
- knowledge about teaching and learning
- appropriate attitudes and commitment
- competence with appropriate teaching strategies
- ability to select, modify, and design curricula
- ability to communicate effectively.

To achieve these, programs for educating those in guidance and leadership roles that influence the education of teachers must have specific components which lead to the capabilities desired.

5. Assessment and evaluation for scientific and technological literacy

Whereas assessment is most commonly used in formal school classrooms, there is need to use evaluation as a tool for accountability in all scientific and technological literacy programs. Educators need to assess regularly and meaningfully the academic achievement of their students in scientific and technological literacy. Both valid and reliable assessment strategies need to be developed. Equally important, teachers must devise methods for monitoring their own teaching of the programs they operate and the system in which they carry out their profession. There are many issues on which to focus, but research data and exemplary details are needed for:

- the role of assessment and evaluation
- assessment and evaluation for all desired goals (attitudes, creativity, the nature of science, application of knowledge), not just knowledge of concepts, vocabulary, and processes
- public acceptability of appropriate assessment and evaluation
- how such assessments/evaluations can be identified and monitored in formal and non-formal situations
- use of formative as well as summative evaluation strategies
- self evaluation for users of technology
- the role of evaluation agencies.

Assessment and evaluation should be directed to providing usable information for improving the quality of life.

6. Non-formal and informal development of scientific and technological literacy

While formal schooling provides a major mechanism for the enhancement of scientific and technological literacy, non-formal education (museums, science centres, zoos) and informal education (the media, social events) also provide significant avenues for development, either linked with or independent of formal schooling. In fact, for adults and out-of-school youth, these forms of education play the major role in gaining or enhancing scientific and technological literacy. Knowing this, serious proposals must consider:

- identifying, supporting and publicising exemplary non-formal and informal mechanisms
- educating personnel for undertaking non-formal and informal efforts
- linking schools with non-formal and informal efforts
- evaluating the effectiveness of various non-formal and informal approaches.

Expected results of Project 2000+

The expected result from implementing Project 2000+ is enhanced scientific and technological literacy for all students as part of basic education and for all adults. Specifically the results expected are:

- Closer links between goals of basic education in general and the teaching of science and technology in schools at the basic education level
• New curricula for compulsory school science and technology that have a greater degree of relevance for all students and which promote scientific and technological literacy above 'science for scientists' strategies.

• New resource materials together with detailed guidelines for use that relate to the society outside the school or the learning centre and emphasise relevance.

• New pre-service teacher education programs that promote scientific and technological literacy as the goals of science and technology education programs.

• New in-service teacher education programs that emphasise scientific and technological literacy philosophies and put forward ways in which such literacies can be encouraged.

• New assessment mechanisms appropriate for the emphasis on science and technological literacy.

• New formal/non-formal education links that promote basic science and technology education and enhance adult literacy.

• Greater involvement of NGOs in project design and promotion.

• Greater emphasis on evaluation of research, on programs, and on training of personnel in evaluation techniques.

Project considerations at an operational level

1. Re-examination of curricula strategies

A common science curricula strategy today can be described as 'fundamentals first'. It is based on the idea that appreciating the uses of science and understanding the issues where scientific research is being undertaken needs a grasp of fundamental concepts. The concepts are introduced in a 'science' framework usually using scientific conceptual headings eg force, work, properties of matter, heat, light. The approach is logical and orderly from a scientist's point of view and allows the introduction of experimentation, investigation and the build up of scientific learning in a hands-on and orderly manner. Teachers like it, often because it was the way in which they were taught and furthermore it seemed logical and appropriate for them when they themselves were learning science in school.

But this approach is now being perceived as turning students away from science studies. Whilst logical to the scientist, it seems largely irrelevant to life within society. The problems and issues in society are complex, technology related and are very different from the conceptual build up being developed within the school.

As scientific knowledge increases, so does the basic learning. Much of university study of previous decades is now taught in schools. By emphasising fundamentals, there is less and less time to relate to the societal implications of science, or to look at some of the applications except as an afterthought. Science as a subject, useful outside the school, becomes sterile and irrelevant.

Whilst it is undoubtedly important for future scientists to have a fundamental grasp of scientific concepts, few students enter such a career. Yet scientific and technological literacy is a need of all students, irrespective of their future vocation. It is important for all students to have a grasp of a wide range of scientific skills and be in a better position to cope with change in technology, assess risk associated with technology, make decisions with respect to the technology they encounter or which affects their society and to appreciate their role in the 'global village' that technology affects.

Science education in schools has failed to provide students with the attributes and skills to meet the challenges and issues in society that impinge upon science and technology. Worst, the science and technology curricula in schools have not even been able to keep pace with the rapid changes in science and technology within the society.

Basic education in the field of science and technology does not therefore mean that a fundamentals-first approach is mandatory. A new strategy is needed. A relevant-to-the-needs-of-society approach needs to be given greater consideration. Such an approach has been attempted in some projects under the names of STS, SADIS, or an industry-oriented approach. The approach stems from:

• our interests in our environment/industry

• our needs (skills both personal and societal)

• the concerns in society

• betterment of the society leading to

• sustainable development ideas.

2. Technology-led science curricula

The made world around us is technological therefore confining science education to nature study is no longer appropriate. This made world is a series of technological products and it is thus no longer applicable to study science in a technological vacuum. Humankind has striven for a better quality of life and the trials and tribulations along this path provide the setting for science and technology education in a relevant setting. The setting emphasises issues, recognises aesthetic beauty, realises the nature of science and relegates factual knowledge to a need-to-know basis. Basic science courses cannot ignore the processes of technology, which need to be made an integral part of science teaching. A technology-led science curriculum seems to be more appropriate. The science begins from that which is visible in the society and, where complex, breaks it down to the inherent concepts. The science is systematic, from an environmental or experiential point of view. Previous fundamentals, such as the periodic table, are inappropriate. A systematic study of the elements is no long appropriate.

Chlorine, for example, is not a topic of study - its relevance is likely to be included from a study of bleach, because that is experiential reality.

3. Emphasis on process skills in science and technology teaching

Personal skills need a greater promotion in science and technology teaching. Manipulative skills gained from experimentation are not all that is required of science and technology teaching. The experiments must be meaningful and lead to greater involvement in the design, method of operation and the objectives to be achieved. Design and planning skills need greater attention. And to illustrate that reality is a compromise, greater attention needs to be placed on alternative solutions to problems where economic, political or societal considerations may play important roles. Activities such as role
playing, brainstorming, project work and dramatisations need to be given greater consideration.

4. Role of the textbook in science and technology teaching

Whilst a reference book containing data has a useful place in teaching, a 'guidebook' which one might consider to be the role of the textbook needs to be imaginative, stimulating and relevant to the objectives of the teaching. The textbook is, however, all too easily the 'spoiler' of lessons as it supplies 'the answer', removes investigatory spirit, puts undue emphasis on conceptual understanding and ignores process and communicative skills.

5. Summative assessment of students

With the removal of the textbook, the challenge to more appropriately undertake assessment of student achievement can become a reality. External examinations have tended to take the textbook as the curriculum, emphasise conceptual understanding and give scant attention to process skills and, certainly, to any non-written skills such as debating, acting or even manipulating. A great challenge is therefore to change the external examination system and to find ways to involve teachers in the summative assessment of student ability. This is certainly challenging, as it will ask much of the teacher who is more familiar with formative assessment and recognises the conflicts that can arise if formative and summative assessments are combined. The place of criterion referenced assessment and student progress development profiles need serious planning, research and development.

6. The place of the school within the society

A major challenge is defining the role of the school in the learning of science and technology. It is well recognised that students learn much from their surroundings, the society, the radio or television, the science and technology museum, science centre, or from involvement in indigenous technology. For a school to isolate itself from such places of learning is obviously undesirable, especially when ideas are presented so much better than in the school. Look how much better a science centre or a museum is able to present facts, data, historical ideas and cater for experiences with technology. Why should a school contemplate competing with such institutions? The links between the formal and the non-formal need to be greatly strengthened so that the school can devote far greater attention to societal skills, even within science teaching, and less to acquisition of facts. It might be going too far to side with a vision of science learning in the 21st century as being of a student sitting at home with a computer, connected to information centres and able to communicate with the teacher, then coming to school to learn how to interact with other students. But certainly putting students together in a concentration such as that within a classroom calls for careful attention to be paid to the type of learning opportunities this best creates for the student.

7. School-community links

The school-community link can work both ways and the role of the school as a learning centre can play a great role in the community, involving the community in the student learning and also allowing the community to benefit from being a centre which meets their own learning needs. Adult education in scientific and technological literacy can be seriously attacked by the school being more open to the community even to the extent of members of the community being involved within the lessons being offered to students. Students would also present, guide and otherwise relate to the community in work related, or other programs.

Designing schemes and implementing scientific and technological literacy

It has long been recognised that formal, non-formal and informal education play specific, yet important and often interrelated roles in guiding the development of a country. It is illustrative how the UNESCO/ICASE project initiative, planned on a worldwide scale, can be translated into meaningful developments within a country. In so doing it must be emphasised that developments and their implementation will be, and are planned to be, at an individual country level. External agencies are planned to be involved only at a supportive, rather than a leading role.

The outcomes from an international forum (to be held in July at UNESCO headquarters) are expected to be disseminated to governments for consideration. At the same time, guidelines are needed, to evaluate current programs for suitability in achieving the degree of scientific and technological literacy desired, and a national task force created to oversee developments. Project 2000+ calls for external agents, such as UNESCO and ICASE to provide training and evaluative support for developments.

Whilst developing scientific and technological literacy is a many faceted task that takes place over a considerable period of time, it is anticipated that one area of major development is curriculum within the formal school setting. Outcomes from the international forum are expected to give specific proposals for reforming primary and secondary school science and technology curricula so that they address problems for the school population as a whole. This is not an easy task as it has now been recognised that providing a degree of scientific and technological literacy in society at large is not the same as, and may not even complement, science and technology education in further education. It is expected that much time and energy will now be needed if countries wish to seriously address the literacy side of science and technology that affects all members of their community, irrespective of their interest, aptitude, or need of academically oriented science learning.

One curriculum area which needs special attention, as much research has pointed to large discrepancies, is that between the 'intended' and the 'implemented' curriculum. This often comes about by the curriculum being specified nationally by a group of 'experts' and this is then disseminated to schools in a trivial manner. The usual source of guidance for teachers becomes the external examination, but this is limited in its ability to recognise literacy objectives and also the expert role of the teacher who includes local relevance, especially where this centres around societal issues.

Curriculum development, initiated by curriculum developers, can be described as a 'top-down' model and no matter how refined, the developed syllabus, or curriculum, represents an intention that may face implementational difficulties. Curriculum development initiated by teachers has often been described as the 'bottom-up' approach. Such development is
difficult to achieve. The involvement of science and technology teacher associations, putting forward the needs with respect to a 'bottom-up' development, can help to provide the balance between innovative ideas from the developers and implementation possibilities (particularly teaching time allocations) from the practitioners.

Science and technology teacher associations represent a group of enthusiastic teachers committed to narrowing the gap between the intended and the implemented curriculum. Their involvement in the curriculum development process enables operational ideas to be incorporated at an early stage and assists the important dissemination mechanism i.e. allowing teachers to comprehend the philosophy of any curriculum renewal. Their members are teachers who can try out curriculum ideas and by interacting within a science or technology teacher association, play a big role in the evaluation process. It is anticipated that science and technology teacher associations would play a major role in the development and implementation of curriculum. For this the teachers would obviously need strong support as they will be volunteering, in effect, for a second, and probably unpaid, time consuming task.

Developments within a country is thus envisaged as a team effort where the overseer would be a task force, made up of Government and non-governmental organisation representatives. Details are purposely left vague at this stage as developments would be dependent on the wishes of the various countries that are involved. However an important component on which UNESCO and ICASE would place emphasis is the training of personnel within a country both in developing intended guidelines and in implementational or evaluative strategies.

**Implementational Strategies**

'Give a man fish and he can eat for today. Teach the man to fish and he can eat for a lifetime.'

Intention is not enough. Implementation is also crucial. Implementation is dependent on skill, resources and perhaps most crucial of all, attitudes. Intentions need implementational support. Success needs to be nurtured and monitored through evaluation programs which relate to attitudes as well as achievement. For this, the practitioners (teachers an fieldworkers) need to be actively involved. Partners in Project 2000+ are international NGOs linked to the practitioners. They have an important role to play in assisting teacher associations and the international NGOs themselves also need strong support.

**Overseers of projects**

This is intended to be national task forces, linked to a regional network organised by the project 2000+ steering committee partners. The national taskforces are intended to consist of governmental and non-governmental organisation representation. The intention is that representatives would have organisational support and would thus not be acting in an individual capacity.

The taskforces would be expected to oversee the whole project from the development of strategies, to trialling of curricula/materials, teacher education programs, assessment strategies, formal-nonformal links, etc. to evaluation of the project. They would be expected to be able to call upon expertise from the regional network if needed. The task forces would also be expected to obtain information from databases in support of national developments.

**A possible mechanism for the operation of a project nationally**

- Evaluate the current situation by conducting a needs assessment
- Carry out planning work to develop projects in the area of scientific and technological literacy in areas of national interest e.g. curriculum development, materials development, teacher education, assessment strategies, linking formal and non-formal education, enhancing S&T literacy for women, establishing a relationship between science education and environmental education, health education, sustainable development.
- Develop models to promote scientific and technological literacy in these areas.
• Create strategies for curriculum/materials development and/or training programs to follow up with target groups on the models developed.
• Create strategies for teacher education, teacher acceptance and, above all, teacher motivation towards the project.
• Develop strategies for evaluation of project at its various stages.
• Develop strategies for assessment programs for students linked to scientific and technological literacy in the 21st century.
• Initiate pilot studies, evaluate, re-trial and re-evaluate.

Main goals expected from the project
• Teaching of science and technology in schools at the basic education level and in non-formal centres more closely linked with and relevant to society
• Positive attitudes towards science and technology in the schools and the community
• Greater skills in decision making, problem solving communication achieved through science and technology teaching
• More relevant curricula in science and technology for scientific and technological literacy for all
• Development of teaching resource packages
• Use of interactive teaching methods as the mainstream of science and technology education
• Enhanced teacher education programs
• Greater involvement of teachers and NGOs in the development, dissemination and evaluation of programs
• More relevant assessment programs more closely linked with the goals of science and technology education
• Development of effective evaluation and assessment packages

Conclusion
It seems clear that in a world of ever expanding knowledge where new technologies are introduced at a faster and faster pace, there is an urgent need to examine seriously education related to scientific and technological literacy for all. The following are areas which need attention:
• Development, dissemination and evaluation of curricula and curricular materials that link formal and non-formal education, encourage teachers to use innovative classroom practices and to make use of the expertise of the non-formal sector, including village crafts and technologies. Curricula to be designed which integrate science and technology with societal concerns and promote objectives emphasising skills in problem solving, decision making and communication.
• Effective teaching and learning strategies in a given situation. Cost effective, innovative 21st century experimental rooms, mobile science and technology rooms, electronic visual aids and innovative teaching strategies which make good use of all community resources (institutional skilled personnel, etc).
• Pre-service and in-service education programs, particularly with follow up and evaluation; the training of educators of teachers and field workers
• Assessment strategies for use with students that can form acceptable alternatives to the summative emphasis now being practised in many countries. Research into examination validity, guidance to examination boards and the conducting of employer evaluations
• Formal or non-formal programs portraying a positive image of science and technology and covering aspects such as determining risk assessment, education for a changing society, how to cope with new technologies, the place of alternative technologies in sustainable development and the recognition of the world as an environmental 'global village'.
• Education of women, minorities, disadvantaged persons in seeing science and technology as improving their quality of life and, used wisely, of benefit to humanity in the future.
• Promotion of education emphasising a balanced picture of the place of industry in society, the decisions that need to be made for sustainable development and in providing the expertise for industry in the future.

Project 2000+ is an ambitious program. Yet governments in many countries wish to place an emphasis on science and technology education for all. Project 2000+ sets out to give science and technology education renewed attention so that formal and non-formal programs can adequately be restructured in time to keep pace with the needs of the 21st century.

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Reminder to Renew
Individual and Library Subscribers to Science Education International are reminded to renew their subscriptions for 1993 before June 1993
Subscription rates and address details are on page 1
Pre-College Science Education in Thailand

by Naruemon Yutakom & John E Penick

For centuries, the Buddhist monasteries played an important role in the education of the Thai people as centers for local and regional tradition. Modern education, brought by traders, foreign ambassadors, and missionaries, came to Thailand in the mid-nineteenth century. Following contacts with foreign visitors, the royal Thai family established and supported the first modern school in Thailand for royal pages in 1870. Later, in 1855, education was expanded for the civil service. However, major expansion of public education did not take place until 1913 culminating in 1921 with compulsory education.

Since 1961, Thailand has been engaged in systematic educational planning as an integral part of its National Economic and Social Development Plan. National Education Development Plans have followed the same five-year pattern as the National Economic Plans. By the end of 1991, six plans had been completed. In the first three plans (1961-1976) emphasis was on developing secondary education to provide medium and high level manpower requirements for a rapidly growing economy. The third plan improved rural access to an education. In the subsequent plans (1977-1991), there was a shift towards increasing educational access improving the administrative system, reforming the curriculum and encouraging equality of educational opportunity throughout the country. The seventh five-year plan, begun in 1992, emphasizes acceleration of educational opportunity for all, especially the rural at pre-primary levels. The lower secondary school will become more accessible to primary graduates and career development will be enhanced.

The Thai educational system is currently under the National Education Scheme of 1977 which conceived education as a continuing life-long process to promote the development of the citizen. In 1978, educational administration was unified under the Ministry of Education, and the previous educational system of 7:3:3 was replaced by the 6:3:3 system. Each level of the 6:3:3 system comprises a diversified curriculum in both general and vocational education. Primary education is compulsory and special education and non-formal education are available for every level of education.

With rapid changes in the social, economic, political, cultural and ecological agendas, Thailand again needs educational reform. Acceleration of such reform in Thailand has been influenced by the United Nations adoption of 1990-1999 as the 'Education for All' decade. The United Nations hopes that this will spur Third World Nations to make greater efforts in encouraging their citizens to acquire basic education as well as scientific and technological literacy.

Thailand's National Policy on Education for All, under the scope and guidelines of the World Declaration and the Framework for Action to Meet Basic Learning Needs, recognizes that basic education is the right and responsibility of all people and should be supported by the government regardless of age, gender, socio-economic status, place or residence, religious belief or other constraints. The policy which will serve the educational endeavor in the coming decade comprises:

- Universalization of primary education; expanding basic compulsory education from six to nine years; providing special education for the handicapped; establishing a network of information learning centers to foster community learning
- Eradication of illiteracy (literacy rate in 1985 was 86%)
- Promotion of continuing education
- Participation of non-government organizations in Education for All activities

The program strategies stressed in the National Education Policy include:

- Learning networks
- Administration and mobilisation of resources
- Staff development
- Lifelong learning opportunities

These policies have worked well. By 1991, 38% of eligible Thai children were attending private or public pre-elementary schools, many in three year programs.

In 1991, 94% of children who belong in first grade were attending and their net survival rate at the end of primary schooling was 89%. The enrolment rate for continuing in secondary school was 48%. That same year, 20% graduated from high schools, 75% of whom went on to universities. Under the Seventh National Education Development Plan (1992-1996), the government's Education for All plan is to see that all school age children are enrolled and complete six years of primary education and aims to increase basic compulsory education to nine years so that nearly all primary school graduates will attend secondary school.

There are still some problems in Thailand that need to be addressed through educational efforts. About 3% of children of primary school age in Thailand never attend school. They consist primarily of minority groups of children from the hill tribe population, children of migrant workers, those living in remote areas, disabled children, slum children and other socially and economically disadvantaged children. For those in school major problems are high rates of repeaters and drop-outs, low achievement levels, lack of necessary facilities, personnel and budget, health problems of children due to malnutrition and disease which have affected their
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overall intellectual development.
To help alleviate these problems, on-going innovative projects include:
• establishment of a school cluster system to share resources
• developing schools in rural areas into community development centers
• the Teacher-on-Horseback Project with self study materials for schools in remote areas
• the Self-Reliant School Project
• the School Health Care Program
• the Pre-service and In-service Teacher Training Program

Entrance Examination at various levels
Those who finish their compulsory education at grade 6 may go on to secondary education by passing an examination at the school of their choice. Students in 38 designated provinces who pass the exam for secondary education receive government support in terms of free tuition and learning materials. In the Bangkok Metropolitan area, where there is school zoning, a special quota is allocated to students whose residence is within the school zone.
To continue beyond the secondary level, students must pass an entrance examination, except for the open universities Ramkamhaeng and Sukhothai-Thanamathat. A special

1992 ICASE YEARBOOK
Science Technology Society
Edited by
Robert E Yager

Available now from
Jack Holbrook, Executive Secretary, ICASE
Science & Technology Education Unit, UNESCO 7 place de Fontenoy, 75352 Paris, France
program, the Thai Institute for the Promotion of Teaching Science and Technology (IPST), allows selected gifted students to study an innovative curriculum without fear of the somewhat restrictive entrance exams. On being selected for the IPST program, students are guaranteed admission to university of their choice.

Science education reform in Thailand

In Thailand, as in other developing countries, there are many problems related to insufficient and inappropriate education, especially in the area of science and technology. Nonetheless, Thailand has made some progress in providing science education in order to educate its people to use science in improving their lives and the economy of the country. As Sippanondha Ketudat (1981) stated, 'the general expectation of science education in developing countries is 'science for development' with the purpose of inculcating scientific knowledge and the inquiry approach to people so as to gain a proper response to the basic human and societal needs in harmony with social, cultural and natural environments.'

The Sputnik event of 1957 had a catalytic effect on science education reform in developing countries as well as the developed countries. Since then, many international and regional organizations have participated in forums to discuss the issue of science education in countries in Asia and the Pacific. These forums have had a significant effect on science education reform in several countries as well as in Thailand. In 1971, Thailand, with assistance from UNESCO, established the Institute for the Promotion of Teaching Science and Technology (IPST) in recognition of needs in science curriculum development. The institute played an important role in science and mathematics education reform in the country. From the beginning, its work was concerned with science and mathematics curricula development at both the primary and secondary levels. Later efforts expanded the reform to many areas of specialization and included some aspects of post-secondary vocational education. Examples of course offerings comprised Electronics and Computer Education, Basic Science and Mathematics in Agriculture, Industrial Arts, Home Economics, Arts and Crafts, and Mathematics for Commerce.

IPST is responsible for developing science, mathematics, and technology curricula. Its objectives are

• to develop and improve science, mathematics and technology curricula.
• to promote teaching and learning methods in sciences, mathematics, and technology
• to promote the study and research of curriculum development, teaching techniques and evaluation in science, mathematics and technology
• to promote networking among the institutes of science and technology in the country and with those of other countries.

Curriculum and its development

IPST has been concerned with the development, testing, implementation and follow-up of various courses in science, mathematics and technology for primary, lower secondary, upper secondary and vocational schools. It adopted a systems approach from the beginning to synchronize and provide adequate preparation for the acceptance of the major outputs and provide a clear insight of needed inputs and their timing and to see developmental tasks as an intricate part of the total operation.

In each curriculum, four areas are developed concurrently: writing of students' texts and teachers' guides; evaluation; teacher training; and acquisition of science equipment. All materials are tried out in selected schools and feedback collected for the final revision for full implementation throughout the country. IPST put in great effort designing equipment at low cost. It then commissioned mass production of this equipment using locally available material and manpower. Moreover, the science curriculum content links with real life situations relevant to Thailand by utilizing data and information on Thailand to illustrate scientific concepts, and to present specimens and materials available in local areas for laboratory activities.

The science curriculum

Primary Level

With the educational reform in 1978, science is no longer taught as a subject but is integrated with health and social studies within the life experience area. Comprising 15% of grades 1 and 2, the aims for life experience are to emphasize the problem solving process and the various aspects of human societal needs and problems, for the purposes of survival and leading a healthy and productive life. Life experience time increases to 20% in grades 3 and 4 to 25% of the total curriculum in grades 5 and 6.

Secondary Level

The general objectives in teaching science at the secondary level are:

• to develop an understanding of the basic principles and theories of science
• to develop an understanding of the nature, scope, and limitation of science
• to acquire skills important for scientific investigations
• to develop a scientific attitude
• to recognize the relationship between science, technology, human beings and the environment in terms of mutual interaction
• to be able to apply knowledge of science and technology to society and living.

At the secondary level, where the credit system is in operation, science is required during all 3 years of lower secondary education. There are six 1.5 credit courses, each taught for 3 periods a week. With 40 weeks per academic year, this is about 16% of the curriculum. Science during these 3 years is integrated and includes soil science, conservation, and environmental education. The curriculum also provides many elective science courses for students who are especially interested in science.

At the upper secondary level, all students are required to take 6 credits in science. There are two programs of science curriculum at this level. Program 1 is provided for students who do not intend to study further in science related fields or those who terminate their studies at this level. The students
may select a variety of subjects (each a separate booklet) from physical and biological science courses. They must complete booklets in the ratio of 5 physical science for every 3 biological science topics. Each course meets 3 periods a week.

The science oriented students in Program 2 are required to study 3 core courses in Physics, Biology and Chemistry for 6 credits (2 credits each). And there are elective courses in Physics, Biology, Chemistry and Biological Technology from which students can select according to how they fit into their future plans for higher education.

In all cases, students are learning to adapt technology, use mathematics, and link theory and practice. Much of this through applications of science knowledge.

The curricula for science are developed by the The Ministry of Education (often working with the Science Teachers Section). These curricula emphasize inquiry, laboratories, and applications of science. Some are adaptations of popular and successful books such as CHEMstudy, BSCS, and others. Many in-service efforts are also conducted by the science teachers section.

While most science classrooms are still teacher-centered and university oriented, more and more teachers are heeding the cry of 'Education for All' and are stressing issues, applications, and student-centredness. Even with a severe shortage of school laboratories, teachers are introducing more hands-on activities. As in most countries, this is a time of serious and rapid educational thinking and reform. The Ministry of Education is well aware of the need to enhance science and technology education and is working to improve teacher education, materials, facilities, and opportunities for students. This reform is encouraged by enhanced communication as well as the perceived need as compulsory education is extended into the secondary school.

**Teacher training**

In order to continue improvement in science curriculum development, the quality of teachers is crucial. The IPST plays an important role in training the staff of instructors and in organizing all the in-service training programs, providing teachers' guides, class equipment, audio-visual equipment, video-tapes and filmstrips, as well as supplementary materials for teachers. The IPST uses an integrated approach for inservice programs, the content being integrated with methodology and with evaluation. Concurrently, the IPST with the cooperation of the Thai Teacher Training Department have established Science Teacher Service Centers (STSC) to facilitate the decentralization of certain aspects of IPST's work, including the school follow-up program, continuing in-service education and evaluation of new courses. The 36 STSCs now established are within the existing teacher training colleges throughout the country.

Although the in-service teacher training improved the quality of teachers to some degree, the pre-service program seemed to be a better way for preparing science teachers. In 1977, after considerable experience and feedback had been gained from the in-service teacher training programs of IPST, the Ministry of University Affairs initiated the 'Thai-STEP Project' by appointing project personnel representatives from the faculties of science, mathematics, from every university in Thailand and from the Teacher Training Department to serve as the project team.

The Thai-STEP group accepted responsibility for identifying the competencies needed for successful implementation of the new secondary school science and mathematics curricula and for developing instructional materials to be used in pre-service programs. The working team conducted research for analyzing the pre-post secondary curricula and the teacher training curricula in Thai institutions of higher education. It also researched the competencies of science and mathematics teachers, collected data to set the hierarchy, content and proportion of various courses in the teacher training curriculum, developed guidelines for the preparation of teachers at the pre-service level for submission to the Ministry of University Affairs, and worked on the follow-up of in-service teacher training and the implementation of the new science and mathematics curricula. Fifteen instructional packages or modules to be used in the pre-service education of teachers were produced from the research information related to science teacher competencies. In 1980-1981, these instructional packages were tested and revised. The revised versions have been accepted by the Ministry of University Affairs and the teacher training staff for implementation in the pre-service teacher training program throughout Thailand since 1983.

**The science talent project**

Besides its major role in development of science and mathematics teaching in schools, IPST is also taking part in conducting other important projects in science and technology education development. The most interesting one is the Science Talent Project. Since 1984 the Ministry of Science, Technology, and Energy, the Ministry of Education, the Ministry of University Affairs, with the cooperation of IPST, have been conducting the Science Talent Project with the aim of identifying and nurturing young children who possess a high level of learning ability and show consistently high academic achievement in science. The first period of the project took 7 years from 1984-1990. The project was implemented by the government and extended to a second period of 6 years.

The Science Talent Project will select lower secondary school students with high level academic achievements in science to study in the upper secondary school where the special science and mathematics study programs are provided. After graduating from school, they will be able to further their study in the Faculty of Science at a designated university without taking an entrance examination. They are also encouraged to continue their studies to their highest potential at Thai and foreign universities.

These students receive scholarships which include tuition and fees, personal expenses and books. After graduating at least with a master's degree, they are offered employment with government institutions of science and technology in Thailand. From 1984 to 1992, there were 3 PhD graduates and 18 graduates with master's degrees in science and technology who were sponsored through the project. There are presently 100 graduates students; 30 are working for PhD degrees and 70 are working for the master's degree. In
addition there are 182 undergraduate students and 65 upper secondary school students in the program.

With a renewed emphasis on education, strong reform efforts, and a growing economy, this is, indeed, an exciting time in Thailand.

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NEW ICASE PUBLICATION

Education in Science and Technology for Development

Perspectives for the 21st Century

Proceedings of ASEET/ICASE Conference '91

Edited by Judith Reay & June George

This new ICASE publication contains the papers presented at the ASEET/ICASE Caribbean Conference '91 organised by the Association for Science Education of Trinidad and Tobago (ASEET) on 27-30 August 1991 at the University of the West Indies, St Augustine, Trinidad & Tobago.

Papers are grouped in three sections. The first section 'Issues in Education' includes papers which take a broad view of policies and practice. One paper urges teachers to question all 'knowledge'; another identifies the need for universities to articulate better with schools and with industry; another argues for much more attention to technology in schools.

The second section 'Curriculum and Educational Strategies' is closer to the classroom and spans primary through secondary to tertiary teaching.

The third section 'Science and Technology and Education' has more emphasis on science/technology, including contributions on topics as diverse as biotechnology, solar dryers, and a steel drum.

The publication concludes with a set of resolutions arising from Conference '91.

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Member associations and individuals are invited to contribute to this section. Suitable items include brief accounts of specific projects of international significance, science education in a particular country, or international and regional seminars and conferences.

COSTED ICSU

Asian Workshop On
Global Change Education

November 22-27, 1993
Madras, India

Introduction

The ICSU Committee on Science and Technology in Developing Countries (COSTED) has identified Science Education as one of its priority areas for its activities. Over the years, COSTED has developed several teaching materials in the form of slide packages, trainer kits, experimental models, etc. Some of these kits are being used in educational institutions in developing countries. Similar projects are under progress even now. The ICSU Committee on Teaching Science (CTS) has as its main objective the promotion of innovative methods of science teaching all over the world and at all levels. It cooperates with other ICSU bodies and other like minded organisations to further the cause of teaching of science. Among its various activities several good quality teaching materials have been produced in the past. One of its recent projects is on 'Education in Global Change' through which it plans to create in students of the 16-18 age group an awareness in the environment around them, how it works and how it is influenced by natural processes and human induced activities.

CTS has already developed several innovative units of teaching material on Education in Global Change in the form of booklets for teachers with portions for students incorporated in them. These booklets also contain authoritative information about the topics and related issues to extend the knowledge of teachers, and suggestions on teaching strategies.

Booklets on the following seven topics have been developed:

• The Global Carbon Cycle
• Remote Sensing – Window on Global Change
• The Changing Atmosphere
• Clues from the Past – Glimpses of our Future
• Energy Systems
• Population and Land Use
• Oceans

The above CTS study material has been prepared for the teacher - student community at large. Some of these units have been field tested with teachers and students in some European countries.

Objective and Rationale

COSTED, because of its interest in the promotion of environmental education in developing countries, is considering an evaluation of the suitability of the material produced by CTS to meet the needs of teachers and students of the developing world. Therefore the main purpose of the present workshop will be to subject these materials to a critical study by selected teachers from developing countries of Asia and examine changes, if any, to be introduced to make them more relevant and meaningful to the concerned students.

As a first step COSTED and CTS are jointly planning to have a six day workshop in Madras to familiarise participants on Global Change Education and to test the material prepared by CTS. The likely participants in this workshop will be senior secondary and pre-university teachers of science, and science educators from Asia. The teachers where possible, would have some experience in curriculum development and their interest would preferably cover education in scientific disciplines or interdisciplinary subjects related to environment.

It is proposed to send the CTS teaching materials to selected teachers in advance so that they can test them with their classes before the workshop and send back their views and suggestions. Some of these teachers will be invited to attend the workshop and participate in it.

COSTED will also identify a group of teachers/teacher educators from the developing countries of Asia who will be interested in writing additional chapters; they will also be invited to the workshop.

Participation

Participation will be by invitation. The number of participants will be restricted to about 40 including participants from India. To enable the participation of as many countries as possible it is proposed to limit in general the number of participants from each country to two. These will have to be nominated and sponsored formally by the parent institution or country with their recommendation.

Workshop Program

The program will comprise three parts: (1) familiarisation of the CTS project on Global Change; (2) review of lessons prepared by CTS; and (3) attempts to write a few new units.

For further information, contact Prof R R Daniel, Scientific Secretary,
COSTED, 24 Gandhi Mandap Road,
Madras 600 025, India
Report on
International Conference on Geoscience Education
by Dennis Chisman

This conference, held in the University of Southampton, England from 22-24 April, was attended by about 200 participants from 55 countries. It is believed to be the first international conference of its kind.

Among the participants were representatives from developing countries including Africa, Asia, Latin America and the Caribbean. There were also several representatives from Russia, Poland, the Czech Republic, Lithuania and Croatia.

The main themes of the conference were:

- geoscience education in schools
- higher education
- geoscience training for business, industry and services
- public understanding of geoscience

There was also a special session on women in geoscience.

The conference was organised by the Association of Geoscientists for International Development (AGID) and the Commission on Geoscience Education and Training (COGEOED) of the International Union of Geological Sciences (IUGS), in association with ICASE, ICSU and the Earth Science Teachers Association in Britain. The British Geological Survey and the Geological Society in the UK provided some local support. Further support was provided by the ODA, The British Council, The Royal Society, The Commonwealth Foundation and UNESCO, as well as by a number of commercial organisations involved with geological sciences.

The conference began with a number of geological field trips to local places of geological interest. These were followed by a program of lectures, workshops, poster sessions and discussions. Abstracts of papers and posters are given in an Abstracts book, which will form part of a final report to be published later.

The AGID and COGEOED committees are to consider recommendations from the conference for a second international conference on geoscience education.

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SOS: Save Our Spaceship Earth
by Mary Lou Biel
Indian Hill School, Illinois USA

The Lake County Business Industry Education Consortium, affiliated with the ISSS (International Student Space Simulation) is located in the USA in the state of Illinois. We are a group of elementary, junior high and high school teachers and pupils who are participating in a Global Environmental, Co-operative Research Project.

We are interested in contacting other countries around the world, as well as our own United States, in an effort to obtain first hand information vital for the success of our project. We are beginning a year long study on the problems affecting the environment of our Earth. We will begin by doing extensive research on targeted global locations and their environmental problems.

After our initial research of particular continents, countries or states is done, we will build simulated biospheres. Within the confines of the biospheres, we will perform experiments relative to the particular global area under study and also gather data from other representative biospheres. We will make comparisons and do problem solving activities.

We are doing this to enhance global awareness among our students and to reach out to others in an effort of sharing our awareness, concerns, and maybe a possible solution or two to the myriad of global environmental problems that concern us all.

Write below for a copy of a data sheet. We would appreciate you completing this sheet, as well as any pictures, maps, articles that would help with our Environmental Project. We will share with you the findings of our research.

Contact Mary Lou Biel, Teacher, Indian Hill School, c/o Lake County Business Industry Education Consortium, 19525 W. Washington Street, Grayslake, IL 60030-1194, USA.
Young people throughout the world are invited to complete this opinion survey and to return it to the address of IASC above.

Teachers and other adults are asked to photocopy this page in order to help this Opinion Forum.

1. There are now more people alive in the world today than have ever lived in total before: (a) Is this idea new to you? (b) Do you believe it?

2. There are more than 5,000,000,000 people alive today, and the population explosion curve shown on this page shows no sign of levelling off:

(a) Do you see this as a serious matter?
(b) Should nature be allowed to take its course, or should measures be taken to help the curve towards a steady level? (Underline the option you support)
(c) List the main consequences you think go with overcrowding.
(d) What population control measures do you think are acceptable?
(e) What population control measures do you think are not acceptable?

3. (a) Do you agree that the greater the number of people, the less the room for wildlife? (b) Does this concern you?

4. (a) Would you like to have children of your own in time? Or (b) how many children do you already have?

5. How many children would you like to have?

6. In view of world overcrowding, how many children do you think you should have?

7. Assuming that it is desirable for all people to have a fair quality of life, and that this does not go with overpollution and exhaustion of resources, what do you consider to be the optimum level for the world's human population?

8. (a) With respect to the possibilities which curve do you think is the most likely to happen? Number......

(b) Which curve would you prefer to happen? Number......

(or draw your own versions on the reverse of your answer page, stating which is 8a and which is 8b.)

9. Please state your:
(a) age
(b) sex
(c) locality (town, county or state, country)
(d) country of birth
The Tellus Syndrome
A Norwegian Project for Environmental Studies

by M Anna Garner
President, The Icelandic Science Teachers Association

The Tellus Syndrome or Earth Syndrome is a multimedia project in environmental studies for educators at all levels, for people working in environmentally related fields including agriculture, industry, public administration, etc., and for adult education organisations and other groups interested in environmental concerns. Colleges and schools could also benefit by selecting materials and ideas from the project.

The project was established to help create a new way of thinking about the environment and about sustainable growth. Based on a report of the World Commission on Environment and Development (Brundtland Commission), the project aims at creating a body of leaders and teachers with competence and understanding in global, national and local environmental issues.

The Tellus Syndrome project is cited in the recommendations of the Third INISTE/UNESCO Nordic Conference on Science and Technology Education as an example of existing or new teaching materials to be developed for wider use.

The project is also relevant to the policy statement on Environmental Education issued last December by the Association for Science Education (ASE) UK.

Developed by the University of Bergen in collaboration with the Norwegian State Institution for Distance Education, the Norwegian State Broadcasting Corporation, the National Film Board and the Gyllestad Publishing Company, the project was launched in Norway in September 1991. The project is now running in its second year and the number of study participants has totalled over a thousand.

Structurally, the study projects are based on extra-mural private study and can be followed on at least four levels of progressive depth. The materials can also be used in the general classroom. The first level can be covered by the general public following the 16 video programs and the 8 radio cassette programs. The second level for non-examination study groups can add basic and supplementary texts along with study guides. The third and fourth levels can lead to accredited courses at various educational establishments, such as universities, colleges of further education and schools. These introductory and advanced courses add more specialised texts, additional video programs, term papers, PC-based test banks, weekend seminars, a week field course and final examinations. In Norway these courses give 2 and 10 university credits respectively.

The cross-curricular themes of environmental education are not always easy to collate. The Tellus Syndrome gives a good base which science teachers interested in developing environmental education programs could use.

The project materials will be on display during the Project 2000 international forum at UNESCO headquarters, Paris in July 1993. It is hoped to make Tellus more widely available in other languages and work is currently in progress on an English version.

Anyone who is interested in receiving more information about Tellus is welcome to contact:

Univesity of Bergen
SEVU - The Centre for Continuing Education
Strømsgaten 51
5020 Bergen
Norway

NVON Annual Meeting

A report by Jan Hendriks, ICASE European Representative

NVON, the Dutch Association for Education in Science, organised very successful annual meeting on the last weekend of March 26-27 at the University of Amsterdam.

About 300 Dutch teachers participated in the different parts of the program which included workshops (eg about Weather and Climate), lectures (eg about Light Food), and many excursions to local industries, university laboratories and the new Amsterdam Science Centre.

The plenary lecture featured the story of 'The big bang' – an inappropriate name for the origin of the universe. This excellent lecture was all too short for the interested participants!

These annual meetings achieve an important aim of providing an opportunity for colleagues from across the country to meet each other.

The reception was again sponsored by the Dutch Association for Chemical Industry, and the buffet provided an excellent opportunity for informal discussions.

Next August, the first years of secondary education will undergo a curriculum reform. There will be one core curriculum for physics and chemistry, one for biology, one for technology as well as one for each of the other school disciplines (Dutch, English, French and German language; History; Geography; Mathematics; Economics; Domestic Economics; Music; Drawing; Handcraft; and Physical Education).

Some students also study Latin or Greek languages. No wonder Dutch children do not have much time to watch television!

Discussions about the new curriculum will resume again after the first year of operation under the new program.
Seeking New Links
An Open Letter from NSTA's International Activities Committee Chair

by Florence Juillerat
Indiana University/Purdue University, Indianapolis
Indiana USA

Each year the United States National Science Teachers Association sets a theme for the organization's programs. "Science for All Cultures", the agenda for 1993-94, expresses the organization's concern with all groups in the process of improving science literacy. "The Teacher is the Key" (to better science education) was another recent theme. Both of these important ideas are now incorporated in a position statement on International Science Education recently adopted by the organization's Board of Directors. The statement will guide NSTA's international projects in coming years. (See the complete text at the end of this article.)

The position statement's declarations are important to you and to the more than fifty thousand members of NSTA because they are a commitment for change in all of our classrooms. NSTA is interested in promoting formal partnerships and exchanges with science teachers and their associations worldwide and promoting conferences on science education. Within the past ten years, the organization has, for example, initiated seminars for educators in Latin American countries, the United Kingdom, and Japan. NSTA and the Association for Science Education [UK] have a continuing teacher exchange lecture exchange for their respective annual meetings. Recent Moscow and Vancouver teacher conferences are to be followed by one in the summer of 1993 in Oaxtepec, Mexico. These conventions feature formats similar to regular NSTA national and area conventions -- hands-on workshops, featured speakers, and opportunities for one-on-one teacher discussions. And, individual state teacher organizations within NSTA have promoted joint meetings with neighbors across the US borders such as the recent annual meeting of the Michigan Science Teachers Association (US) and the Science Teachers of Ontario (Canada). While some of these outreach projects took place near the continental US to encourage full participation by our members, NSTA is now ready to extend its links to locations much farther afield.

As the incoming Chair of NSTA's Committee on International Activities, I invite you to write me with proposals of locations, themes, and formats for possible teacher conferences in your region of the world. We are interested in traditional as well as more focused conferences such as the "Harare (Zimbabwe) Generator" that drew international innovators, young African science teachers using or developing innovative techniques, and teachers in schools who offered their student classes as activity participants. (For more information on the Generator, see the September 1991 issue of Education in Science, Journal of the Association for Science Education.) Perhaps we should encourage more small gatherings such as the 1986 ASE/NSTA joint seminar where a group of US and UK teachers met together, got to know each other, and planned collaborative projects. The seminar resulted in projects in schools of both countries, a continuing series of follow-up programs, and friendships that continue today!

Science Education International contains advertisements for a variety of conferences sponsored by both broadband and focused organizations -- ICASE, UNESCO, ICPE (International Commission on Physics Education), IOSTE (International Organization for Science and Technology Education), GASAT (Gender and Science and Technology). What international activities can NSTA best organize and provide that will enrich and support current projects by other international organizations or that make the best use of the variety of curriculum resources and classroom experiences of our thousands of US teachers working in a variety of disciplines, levels, and school environments?

The NSTA position statement on international science education also charges the organization, and our committee, with the work of encouraging global transfer of information related to science teaching and learning. Should our work focus more on this objective than the others? How can we reach you more effectively? How can we all best tap into the global network of energetic classroom teachers? Here are a few of the many suggestions that emerged in our committee discussions. They are not meant to limit your vision but to encourage your thoughts. Send your recommendations to help us formulate projects of mutual global classroom benefit.

- Should we, for example, devote future journal article space to highlights of recent NSTA convention sessions of international interest? The summaries would be accompanied by names and addresses of presenters to encourage readers to establish networks of teachers interested in particular curricular or conceptual issues. Is this a more efficient way to promote linkages and information transfer for you than more formal published books of abstracts?
- Should we start a videocassette mailing circuit of convention highlights and "hands-on" workshops? Would videotape programs be used at your local teacher meetings?
- What is the appropriate technology to reach isolated teachers worldwide? Are electronic computer networks and satellite conferences that we might organize to share ideas still too far in the future for you? Is it possible to form alliances with local businesses, industries, governmental agencies, or universities to aid in this endeavor? Access to such computer networks for US teachers, by the way, varies greatly from school district to district and from state to state.
- What classroom exchanges or joint
collaborations are possible between school children in different countries?
Very successful ventures, for example, have occurred in the US between
classes collecting acid rain data, monitoring weather, or studying sand
gains from various geological areas. Students have also enjoyed exchanging
small boxes of mysterious artifacts that illustrate principles of
mathematics, science, or technology operating in distant geographical
regions.
• Or, should we use this article space to advertise the unique projects of
individual teachers looking for global collaborators or to seek solutions to
particular problems teachers are having developing science concepts?
With these ideas in mind, I invite you, on behalf of my committee members,
to suggest what activities we might undertake for mutual benefit. Please
share your ideas with us.
Please contact:
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Chair, NSTA Committee on
International Activities, 1993-94
723 W. Michigan
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MNU Annual
Meeting
A report by
Jan Hendriks
ICASE European Representative

About 1500 teachers of mathematics
and science attended the 84th annual
meeting of MNU, the German
Association for Education in
Mathematics and Sciences, 4-8 April
1993, at the Technical University
of the united capital of Germany, Berlin.
The opening ceremony at the Congress
Centre for Education featured a lecture
by Prof Dr Stock, Schering AG, about
genetic technology (and a recital by
the school orchestra of Carl Philipp
Emanuel Bach Gymnasium).
On the first afternoon, about 60
participants joined the ICASE
Symposium. Chemistry
demonstrations were presented by Ludo
Brandt, Jean Jansen and ElisaPauwens
of the University of Leuven, Belgium.
Fred Archenhold, University of Leeds,
UK presented an evaluation of science
teacher education. Onno de Jong,
University of Utrecht, The
Netherlands summarised research
about difficulties in translating
scientific concepts to the learning
abilities of secondary students.
This successful ICASE Symposium
was organised by Prof Dr Hans-Jürgen
Schmidt, University of Dortmund,
who has long been involved in
international activities in science
education. Lectures were presented in
German and this contributed to the
large delegation of German teachers
attending the discussions.
The program featured lectures,
demonstrations, workshops and
excursions relating to mathematics,
physics, chemistry, computer science
and astronomy.
Participants came from Germany (both
East and West), Austria, Switzerland,
France, Belgium, Luxembourg, The
Netherlands, Italy and the United
Kingdom.
The next MNU meeting will be held
from 28th to 31st March, 1994 in
Karlsruhe.
Evaluation of the educational benefit of a special exhibition at an interactive science centre

by R A Schibeci

The role of non-school sources of science learning, including interactive science centres, continues to be a source of interest. Such centres are one of the many sources of what is generally termed informal sources of science learning. The interest in such out-of-school sources of science education continues (Lucas, 1991).

The role of interactive science centres has been questioned by some (see, for example, Shortland, 1987). In order to arrive at a fair judgement, however, it is necessary to examine what evidence there is to support the educational role of these centres. This report is a contribution to the growing literature on the educational impact of interactive science centres.

Interactive science centres

As Bhattacharyya (1988) noted, the word 'museum' has associations with 'musty, dusty, dingy places'; they are often filled with 'rows upon rows of static technical devices of a bygone age or jars full of pickled animals or plant specimens or stuffed animals'; visitors are encouraged to gaze silently on these exhibits. The newer kind of museums are characterised, according to Bhattacharyya, by a number of features which include: an emphasis on contemporary science and its technological applications; encouragement of visitors to 'interact by pushing buttons, turning cranks, lifting levers'; and, an emphasis on scientific principles and processes, not just static display. These centres also offer educational programs usually oriented towards local schools.

Scitech Discovery Centre in Perth, Western Australia, is one of the new breed of interactive science centres. 'Sports Works' was a major exhibition planned and built by Scitech. There were sixteen exhibits, complemented by a program of special events. The focus of the exhibition was on health, sports, fitness and exercise. It was designed to help people appreciate how their bodies can benefit from exercise and the particular skills that are involved in a variety of sports.

Aim

The aim of the evaluation study reported here was to assess the impact

Valuable insights on teaching and learning may be gained from research and it is the aim of this section to bring significant research information to the attention of science teachers, with a view to helping them in their important work.

of a Scitech visit on the knowledge of a group of school students and a group of adults. More specifically, students and adults were asked to work through a pre-determined pathway, which constituted a subset of the Sports Works Exhibition. The focus of the evaluation was on the knowledge of these adults and students of some general health issues, and what their perceptions were about the link between exercise and health.

Sample

School students

It was decided to include some primary and some secondary students in the sample. Year 6 and Year 9 students were chosen, as these would cause minimal disruptions to the schools concerned.

Students from six schools were involved. A year 6 class from each of three primary schools and a Year 9 class from each of three secondary schools participated in the evaluation.

The schools were chosen to draw from populations from quite different areas of the metropolitan area of Perth, Western Australia. All were government schools.

The three secondary schools were selected because the Head of Science was known personally by the secondary education officer at Scitech Discovery Centre and it was anticipated that each would be willing to involve a Year 9 class in the evaluation study.

The three primary schools were selected at random from a list of schools in their respective suburbs. At each school, the principal was asked to nominate a Year 6 class. As for the secondary school classes, a requirement was that the class had not previously visited the Sports Works exhibition at Scitech as part of a school excursion. Also, classes were chosen so that they consisted largely of students of average ability for that year group.

A total of 171 students participated; from these, there were 151 useable responses. Of these 151 students, 52 per cent were female.

Adults

Initially, the intention was to approach existing adult groups (such as hobby or other special interest groups) to participate in the evaluation study. Such intact groups would facilitate any necessary follow up. However, despite numerous approaches, one intact group only participated, the members of a bowling club. The remainder comprised a sample of adults who visited Scitech without any approach from an evaluation team member.

A total of 137 adults were approached, from whom 107 useable responses were obtained. Of these 107
respondents, 63 per cent were female.

Procedures

Students

All students sat for a pre-visit and a post-visit test in their normal classroom. The tests were administered within two to three days of the visit. At SciTech, students worked through an especially designed Sports Works ‘Pathway’, which was indicated on a map provided to them. This was followed by the viewing of a Sports Works demonstration. This visit lasted between 90 and 120 minutes. The students, teachers and other adult supervisors were admitted into SciTech free of charge in exchange for taking part in the study.

The first part of the student questionnaire consisted of 15 multiple choice questions related specifically to the set of the Sports Works exhibits in the pathway. Sample questions were as follows:

A healthy heart, compared with an unhealthy one,
(a) will pump more blood with each heart beat
(b) pumps redder blood (blood with more oxygen)
(c) does not pump as much blood with each heart beat
(d) is identical in appearance

In a short running race, a fast start is very important. To start the race quickly, it is best to use
(a) a standing start
(b) a standing start and starting blocks
(c) a crouched start
(d) a crouched start and starting blocks

The second part of the questionnaire contained a series of questions that asked them to nominate whether they participated in a range of activities, as well as asking them whether they thought these activities might be related in any way to health.

Adults

In addition to the members of the bowling club, a sample of adults who visited SciTech were approached to take part in the study; this occurred on four different days. They were invited to participate in the survey in exchange for free entry. They were asked to fill in a pre-test, follow the (student)

pathway through the exhibition on a map provided to them, and finally to complete a post-test.

The first part of the adult questionnaire consisted of 10 multiple choice questions. The second part included a series of questions on activities and sports they participated in, and possible links between these activities and health. Common to both the student and adult multiple choice questions were four that dealt with general health issues, and three that dealt with exhibits in the pathway; these seven questions were designed to allow a direct comparison between student and adult responses.

Ten of the adults who participated were contacted two weeks later by telephone to check on the responses provided in the questionnaires.

Results: multiple choice questions

Students

Summary statistics for the 15 multiple choice questions are given in Table 1. Of the 15 questions, four were related to general health; a score was computed for this scale (HEALTH). The remaining items related to specific exhibits; a separate score was computed for this scale (EXHIBIT).

Finally, a total score (TOTAL) for the 15 questions was computed.

T-test comparisons revealed that the difference between each of these three pairs of means (pre- and post-test) was statistically significant. Analysis of these data by gender showed two statistically significant differences only, on the mean scores for pre- and post-test values for EXHIBIT, respectively. As expected, the mean scores for the Year 9 students were uniformly greater than the corresponding values for the Year 6 students.

Adults

The first part of the adult questionnaire comprised ten multiple choice questions. Of the 10 questions, four related to general health; a score was computed for this scale (HEA). The remaining six items related to specific exhibits; a separate score was computed for this scale (EX). Finally, a total score (TOT) for the 10
questions was computed. Summary statistics for each of these three scales are given in Table 1.

Comparison of adult and student results

In the multiple choice section, there were seven items common to the student and adult questionnaires. A score was computed for the four items related to health issues (HEAL), and a separate score computed for the three items related specifically to the exhibits (EXH).

T-test analyses revealed that the mean values for both the health (HEAL) and exhibit (EXH) scales on the pre-tests were higher for the adults than for the students, and that these differences were statistically significant. However, there was no statistically significant differences in mean values for these scales in the post-tests.

Summary statistics for these two scales (HEAL and EXH) are given in Table 2.

Results: remaining questionnaire items

Students and adults: health and regular exercise

Both students and adults were asked to give reasons why they thought there was a connection between regular exercise and health. The responses were grouped into five categories. The reasons (with per cent in parentheses) given by 151 students who gave useable responses were: Keeps one fit/healthy (34.6); Burns cholesterol (17.3); Burns fat (9.6); Works muscles in the heart (7.7); Keeps heart rate/blood flowing (4.5); No response (26.3).

Of the 107 adults, 70 gave some responses to these questions. These responses were categorised. The reasons (with per cent in parentheses) given by these adults were: Keeps one fit/healthy (61.4); Keeps heart rate/blood flowing (12.9); Burns fat (8.6); Increases oxygen in the blood (7.1); Works muscles in the heart (7.1); Increases self esteem (2.9).

Adults

In response to the question, 'Where would you go, or whom would you contact, if you wanted more information on health issues?', 54.7 per cent nominated a 'doctor' and 28.0 per cent government departments. Other sources nominated were: fitness centres/gyms (6.7 per cent); library/books/TV (5.3 per cent); hospital (2.7 per cent); heart foundation (1.3 per cent); and, universities (1.3 per cent).

When asked to nominate sports they were currently active in, 41.6 per cent nominated 'none'. Apart from lawn bowls (nominated by 27 per cent), no individual sport was nominated by more than six per cent of the sample. Those who nominated lawn bowls would have been members of the only intact adult group to take part in the survey.

Discussion

Student mean scores on both general health questions and exhibit-specific questions showed a statistically significant increase over the two test occasions. However, the pre-test scores were relatively high, which indicated that students were generally well educated in the area of health covered by the Sports Works exhibition. The Scitech visit appeared to reinforce this knowledge, as well as produce a modest increase in mean scores.

Adults showed no such increase. They, too, appeared to have a good general health knowledge, but this did not increase as a result of the Scitech visit. This may be explained in part by the methodology employed with the adults. As indicated earlier, the original intention had been to approach existing adult groups to participate in the evaluation study. However this turned out not to be possible, and so the evaluation team resorted to approaches to adults as they visited Scitech. This procedure was not satisfactory, as respondents filled in the pre-test at the entrance to Scitech, and filled in the

<table>
<thead>
<tr>
<th>Table 2</th>
<th>Summary Statistics for Common Items</th>
<th>Students (n=151) and Adults (n=107)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Group</strong></td>
<td><strong>Scale</strong></td>
<td><strong>No. of items</strong></td>
</tr>
<tr>
<td>Student</td>
<td>HEAL (pre)</td>
<td>4</td>
</tr>
<tr>
<td>Adult</td>
<td>HEAL (pre)</td>
<td>4</td>
</tr>
<tr>
<td>Student</td>
<td>HEAL (post)</td>
<td>4</td>
</tr>
<tr>
<td>Adult</td>
<td>HEAL (post)</td>
<td>4</td>
</tr>
<tr>
<td>Student</td>
<td>EXH (pre)</td>
<td>3</td>
</tr>
<tr>
<td>Adult</td>
<td>EXH (pre)</td>
<td>3</td>
</tr>
<tr>
<td>Student</td>
<td>EXH (post)</td>
<td>3</td>
</tr>
<tr>
<td>Adult</td>
<td>EXH (post)</td>
<td>3</td>
</tr>
</tbody>
</table>

Note: T-test analyses refer to comparisons of mean values for adults and students.
post-test inside the Centre, where it was noisy and distracting. Further, many who completed the pre-test did not complete a post-test, despite the free entry provided in exchange for participation. For example, on one of the four occasions when data was collected, 70 adults completed pre-tests, but 50 only of these completed the post-test. Clearly, this is an inefficient procedure. Future evaluations will need to consider other ways of attracting adult groups.

Investigation of adults' knowledge and perceptions is important, as there is a need to add to the existing data in this area (for example, Schibeci, 1990). However, alternative methodologies need to be explored with adults in future evaluation studies. It may be that adults do not see the science as it is presented in exhibits as relevant to them, and that they need opportunities to 'reconstruct' the knowledge in ways that makes it useful to them (Layton, 1991).

In general, then, this evaluation study supports the view that there is an educational benefit to school students of a directed visit to Scitech. This adds support to the findings of the earlier evaluation study at Scitech (Dymond, 1991).

An additional finding is that students appear to be well educated in the general health area covered by the Sports Works exhibition; for this, it is likely that schools and their teachers can take the credit.

With adults, the study reveals that no increase in knowledge resulted from the visit, although adults appeared also to be well educated in the general health area covered by the Sports Works exhibition; this was confirmed through the telephone interviews.

Further, these interviews indicated that adults go to Scitech either to take their children or to take visitors. That is, these adults do not go to Scitech with the intention to be educated.

It is important to continue evaluations of the impact of learning of interactive science centres. We need to know how interactive science centres can be effective when they are used as an adjunct to the science classroom with school students. The centre becomes, in effect, a giant classroom.

Are there other ways in which these centres can contribute to science and technology education? Does Shortland's (1987) claim, that they are places of entertainment, have any validity?

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Shortland, M (1987, July 16) No business like show business Nature 328, 213-4

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BOOKS FROM THE SCIENCE MUSEUM 1993

The Science Museum in London has an active publishing program in the history of science and technology and the public understanding of science. Our books range from general introductions to subjects such as electricity or light to reference works for academics.

A catalogue listing all titles, prices and an order form is available by writing to:

Victoria Smith
Publications Assistant
Science Museum London
Exhibition Road
London SW7 2DD
UK
The Iowa Chautauqua Program
A Model for In-service Science Education

by Robert E Yager

If real reforms in science education are to occur, teachers must change. They must change their ideas about the meaning of science and their views of effective teaching. Most educational reforms undertaken during the past two centuries have resulted in little real change even though the goals and ideas of the reformers were articulated well. We have never been successful with educational reform. We have never identified programs that have been effective in stimulating change in teachers who ultimately determine if changes in the classroom are to occur.

Too often anticipated change is defined by new curriculum frameworks. Across the world curriculum committees – often established by government ministries of education – are at work producing new courses and course sequences that teachers are expected to follow. The contention is that if teachers use the new and improved materials that reform will have been accomplished. A long history suggests the fallacy of this logic.

Yager (1988) found in studying in-service educational models that the most effective ones were elective ones that teachers sought out and ones that lasted more than a few days. The study also identified the importance of having some of the most innovative teachers as vital parts of the instructional team. Such teachers provide the perspective of teachers who are faced with daily problems and direct experience with dealing with them. They can provide concrete examples rather than theoretical suggestions. They can provide enthusiasm and living examples of the changes needed in terms of setting goals, perfecting new instructional strategies, analyzing new materials, and devising more authentic assessment tools.

This section focuses on the pre-service and in-service education of science teachers, and aims to communicate ideas and strategies which will assist science teacher educators to enhance and enrich their pre-service and in-service programs.

This was the setting when the Iowa Chautauqua Program was conceived. An in-service model was sought that could help K-12 teachers move to Science/Technology/Society (STS) teaching and programs. Three STS teachers were found and prepared for Lead Teacher roles in the project. Outside STS leaders were identified to assist center staff in establishing the model. The Iowa Chautauqua Program was initiated in 1983 and has enrolled over 2,000 K-12 teachers during the nine year period.

Today the Iowa Chautauqua Program is an in-service model that spends a full year of time with several specific features. Basically the model includes the following:

- a two week leadership conference for the most successful teachers who will become a part of future staff teams
- a three week summer institute where 30-50 teachers will experience STS as students (while also learning about the use of educational technology, human resources, and new assessment strategies)
- a week long experience with STS instruction in the school headed by each teacher enrolled
- a three-day short course in the fall after teachers have completed their five-day STS experience as they plan for a month long STS module
- the four to nine week STS experience in schools with pre/post assessment data, including video records
- a three-day short course in the spring to share results and to assess the general successes with STS in schools.

The Iowa Chautauqua Program operates in the State of Iowa (Central USA) which is divided into 15 Area Education Agencies (AEAs). These AEAs are regional centers responsible for providing special education and administrative services to all schools in their regions. These school districts number from 18 to 57. The Chautauqua instructional sequence is undertaken in each area of the state every three years. During the year after an active Chautauqua Program, the Lead Teachers remain in contact with the ten new teachers for whom they served as mentor. The following year the leaders are helping prepare other leaders from the last Chautauqua ranks and planning for the next program. There is a continuing dialogue about the program and some grass roots promotion seeking out new volunteers/participants in the next Chautauqua sequence.

In a very real sense it is the collaboration and team approach responsible for the change. Teachers are helped by the most successful student-centered teachers in the year long sequence. Teacher enrollees help define the real issues preventing reform and change; they also help develop correctives which they try and evaluate. The structure of the Chautauqua Model is less important than the processes which are modeled by the entire staff team.

The Chautauqua program seeks to accomplish certain specific objectives.
These include:

- increased confidence in K-12 teachers to teach science
- a greater understanding on the part of teachers and their students of the basic ingredients of science (i.e., questioning, explaining, testing ideas)
- more focus on career awareness relative to science and technology
- more concern for positive student changes in six domains of science education.

The domains identified as outcome goals for science courses include:

- Concept domain (mastering basic content constructs);
- Process domain (learning the skills scientists use in science);
- Creativity domain (improving quantity and quality of questions, explanations, and test for the validity of personally generated explanations);
- Attitudinal domain (developing more positive feelings concerning the usefulness of science, science study, science teachers, and science careers);
- Applications and connections domain (using concepts and processes in new situations); and
- Worldview domain (formulating an accurate picture of the nature of science and technology).

Significant improvements are attained in all STS classes in these six domains when compared to situations where science is approached in more traditional ways.

The Iowa Chautauqua Program is viewed as a model worth emulating for the following reasons:

- over 95% of the 30-50 teachers enrolled at each site complete the entire sequence
- all who complete the sequence report significant changes regarding their perceptions of their own teaching
- in excess of 90% of all participants report (with actual assessment scores) positive changes in their students who experience STS and the new mode of teaching it requires.
- nearly 20% from each in-service group excel and aspire to leadership for further projects in their AEA
- Administrative, parent, and business/industrial leaders become active collaborators in the reform.

Student changes include:

- demonstrated mastery of basic concepts
- ability to define and to use basic process skills
- ability to use basic science concepts and processes in new situations
- growth in creativity skills, including greater questioning, ability to explain, and ability to devise tests for explanations generated
- more positive attitudes about science study, careers, and science teachers.

In summary, the Iowa Chautauqua Program utilizes the following features which are suggested as important as improved models for enhancing K-12 science teaching are contemplated

- introduction of new materials and teaching strategies by example (i.e., teachers being taught in ways we would like them to teach) during summer workshops
- a chance to try new materials and procedures for a short period of time early in the fall (five days)
- a full short course where a longer (30 days or more) innovation is planned which also includes assessment planning
- a 30+ day module structured and taught while in touch with a mentor teacher (one mentor for ten new teachers)

- a spring short course where materials, experiences, and formal assessment results can be shared
- a chance to participate in leadership training for a future Chautauqua Program

The evidence is striking that such a program makes a tremendous difference. Chautauqua-type in-service programs can provide the vehicle for real reform. Could professional societies (as represented in ICASE) be the vehicle for promoting Chautauqua programs that assist with reforms?

References


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STEPPING INTO SCIENCE
Activities Book

The ICASE Stepping into Science Project is planning to produce an Activities Book as a resource for primary/elementary teachers of science.

If you have activities to contribute for publication in such a book or in the Stepping into Science Newsletter please forward to

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ICASE Project Officer
Stepping into Science Project
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Berkshire RG12 7YZ, UK

27
Developing Primary Science in Pakistan
by Hafiz Muhammad Iqbal

Introduction
During the last decade or so, we have witnessed a growing concern for science teaching at primary level. In the past either science was missing from primary school curricula or it was left to the choice of individual teachers. Where it was included in the primary school curriculum, it was taught as a passive activity. With the approach of the 21st century, national governments as well as teachers and teacher educators are committing themselves to improving primary science by putting more emphasis on the process rather than the product. The work of organizations and individuals like UNESCO (1983), DES (1985), ASE (1983), Hodgson and Scanlon (1985), Harlen (1980) and Garson (1988) provide evidence of efforts to improve primary science.

In Pakistan since the mid-seventies, science has become a compulsory component of the national curriculum from grade one through to grade eight. From grade nine onwards, students opt for the science stream because of its role in securing jobs. Science after grade eight is more rigorous and abstract compared to lower level science. Students at secondary level cannot demonstrate the desired level of performance in science because of its weakened component at primary and lower secondary level. Due to a multitude of financial and professional constraints, science at this level was not activity oriented.

Primary Education Project
The need to improve primary science was realized in the mid-eighties. In a needs assessment study, the following factors were identified:
- poorly trained teachers
- poor teaching environment
- inadequate resources
- little or no supplementary reading material in schools or in the home environments of both teachers and students
- no use of teachers' guides or handbooks
- lack of research data on the socio-economic and classroom conditions or behaviour
- inadequate and ineffective INSET programs
- teaching based on rote learning
- assessment geared to testing memorization

With the help of the World Bank, the Primary Education Project was launched in 1987. This project encompasses the development of new curricula, providing building for shelterless schools, training of teachers for new curricula and developing improving primary school kits to incorporate new activities provided in the newly developed curricula. Under this project, for the first time in the country, efforts are being made to strengthen primary education taking into consideration local and national contexts. A number of research studies related to teachers' performance, students' achievement, socio-economic conditions and incentives for primary school teachers are being conducted to give a research base to these developmental efforts. Three separate text-books are to be produced for classes 1-3 following an integrated approach to curriculum. Language, SS and RE are to be included in one subject/textbook and Maths and Science in two different books.

Approach to Science
For developing new science curricula for classes 1-3, the following objectives have been formulated:
- understanding of scientific method and development of a range of basic skills, and relevant content
- awareness of natural resources, their use and conservation
- an understanding of environment and the interactions among human population, plants and animals and the physical conditions.
- understanding the need for communication and transportation as essential elements in development
- understanding and participating in physical activities.

Efforts are being made to weave together appropriate knowledge, concepts, and process skills. The new TLR provides a sufficient body of knowledge and requires candidates to demonstrate a sufficient range of scientific skills, including inquiry, observation, curiosity, simple classification, communication, recording information and problem-solving. Activities suggested are based on the student's prior knowledge of things in their immediate environment, mostly from the rural context.

Evaluation of TLR
Following the development of new curricula, Teaching Learning Resources were developed which are under trial in selected schools. These TLRs include a workbook for pupils and an accompanying teacher's guide which acquaints primary teachers with the rationale and strategies for arranging activities for pupils involving locally available material or the material supplied in the school kit. In developing new TLRs, local experts, foreign consultants and practising primary teachers have been involved. The material will be revised in the
light of feedback received. The flow chart shows steps undertaken to develop new TLRs.

This arrangement is a new experience for Pakistan and it is yet to be seen to what extent these efforts will be successful. One thing which is very clear, however, is that there is a communication gap between local personnel and foreign consultants. Whilst being competent and experienced educators, their lack of knowledge of the Pakistani context limits the effectiveness of their contributions to the development of a sound science program for Pakistan.

References

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MOE (1990) Policy Options for Better Education Outcomes at Primary Level: Report on Bridges Pakistan National Conference, Islamabad: Academy of Educational Planning and Management


About the author

Hafiz Muhammad Iqbal is Assistant Professor, Department of Science Education, Institute of Education and Research, University of the Punjab Quaid-e-Azam Campus, Lahore 54590.
Stepping into Science
An ICASE Primary/Elementary Science Project

AIMS
Stepping into Science is an ICASE project which aims to:

• Establish an international network for teachers to share ideas on the teaching of primary/elementary science and technology.

• Provide activities and support for teachers, thereby encouraging them to include more science in the primary/elementary curriculum.

• Promote the value of science experiences for young children throughout the world.

• Facilitate professional development opportunities for teachers by including sessions on primary science and technology in regional and international conferences.

ACTIVITIES
The Stepping into Science Team is actively involved in a number of projects and activities including:

• Publishing STEPS, the Stepping into Science Project Newsletter. This newsletter contains ideas for class activities at various levels in primary/elementary schools, activities for children to do at home, comments by network members on issues, examples of children’s work, lists of helpful resources and contacts. ICASE acknowledges the contribution of Philip Harris in sponsoring STEPS.

• Contributing articles and ideas for the Primary Science Section in Science Education International, the ICASE quarterly journal.

• Compiling ideas and activities for inclusion in a series of sourcebooks on the teaching of primary/elementary science and technology.

• Coordinating a scheme to encourage children to participate in science and technology activities. Certificates of Participation have been produced, and are available for schools to use in rewarding students as they complete a number of activities. Certificates are colour coded in seven different colours, so that they can be used to acknowledge progress in science from early to advanced levels within primary/elementary schools. ICASE is grateful to BP (Oman) for sponsoring this scheme.

• Organising Stepping into Science workshops and displays of children’s work at national, regional and international conferences.

FOR MORE INFORMATION
Contact the Project Officer:
Sue Dale Tunnicliffe
ICASE Project Officer
Stepping into Science Project
18 Octavia, Bracknell
Berkshire RG12 7YZ
Young reporters for the environment
Observing science while it happens

by Philippe Saugier,
Foundation for Environmental Education in Europe

The Foundation for environmental education in Europe (Fee) conducted a pilot experience called the 'Ozone Project' from 1990-1992. Its promising results have led to the creation of a permanent network of secondary schools under the title 'Young reporters for the environment'.

The Ozone Project: a thousand European students take an inside look at research on polar ozone

What's happening with ozone over the North Pole? Some unusual visitors went to the heart of the research campaign of the European Arctic Stratospheric Ozone Experiment (EASOE) to find out. About fifteen young people - gathered from as many secondary schools across Denmark, Finland, France, Germany, Latvia, Norway, Poland, Sweden and Switzerland - visited the polar laboratories of the EASOE in the very north of Scandinavia to observe the process of data collection from the balloon probes, aircraft labs and ground based instruments which sounded the upper atmosphere during the winter of 1991-92.

A total of three missions provided them the opportunity to observe closely the development of this information and the availability of the scientists who assisted these enthusiastic young people enabled the students to produce living articles about complicated scientific issues.

The inquiries of those visiting the polar laboratories were guided by those they represented through a computer network which was made available by the University of Copenhagen. Despatches, articles and reactions were exchanged there everyday and then gathered into a multilingual newspaper which was published by the students every two months. Each team had carefully prepared the missions by undertaking inquiries in their own school, town and country. The young journalists interviewed leading scientists, members of the government and industrial managers about environmental issues. In this way, they developed an increasingly deeper insight into the causes of the problem and thus formulated appropriate questions.

Financed by several French Ministries (Research, Environment, Education, Youth Foreign Affairs), the 'Ozone Project' showed the willingness of youth and teachers to obtain a deeper insight into the activities of scientific research. It provided an opportunity for these people to inform the public through an original enquiry linking several key fields across Europe - education, environment, science, journalism, new technologies. The success of the first project has resulted in the Council of Europe commissioning Fee to publish a 50 page booklet recording the project as an example of a successful integration of environmental education with the European dimension. This booklet is to be distributed to teachers and institutions in thirty-five different countries.

Towards a permanent network of young reporters

The ozone project provides a new concept in research experiments. Its efficiency proven, Fee defined the main features of a new, broad, long term international program. 'Young reporters for the environment' encourages young Europeans in secondary schools to act for a better understanding of global environmental issues, by committing themselves together with their teachers to the following innovative educational program:

- Facing the real world through studying human interactions with their environment, through means of journalistic enquiries which go beyond usual documentary sources, and through field missions.
- Bringing the scientific community closer to their support base - the general public - and to the teaching of science by taking up their willingness to share their field work.
- Involving oneself in strengthening Europe through exchanges utilising the most advanced technologies of communication to enhance intercultural dimensions.
- Promoting environmental studies in schools, by revealing its pedagogical potential to teachers, and working with teachers to help them implement such programs.
- Contributing to the development of community attitudes through quality programs.

Topics

Encouraged by the success of the 'Ozone Project', the 1993/94 project will focus on the general theme of the influences of human activities on the global environment. Each topic will include a focus on local investigations and field missions based on major scientific investigations. Topics under consideration include:

- simulating an accident involving the release of a radioactive cloud over Europe (air pollution, nuclear energy, nuclear safety)
- stratospheric ozone experiments
- oceanographic projects (greenhouse effect, global change, oceans, pollution in seas)
• fusion energy
• renewable energies
• environment and development

Organisation

The program is organised at the national level by official member bodies of Feee. A coordinating secretariat is funded at the international level. Denmark, France, Greece, Italy, Norway, Portugal, Spain and Turkey are planning to participate during 1993-94. Teachers from these countries are welcome to contact Feee.

Schools in other countries are also welcome to join as informal associate participants or as correspondents. Feee is looking for new operators to join the program at the organisational level and to implement programs in other regions of Europe.

Future developments

Since Feee has a strong vision for promoting its program to schools as well as the general public, it welcomes the development of links with ICASE. The ICSU-CTS project 'Education in Global Change' provides an opportunity for Feee to establish valuable links with CTS.

Feee looks forward to its participation in the International Forum for Project 2000+ to be held during July 93 in Paris. This will provide an opportunity for us to extend our activities beyond Europe.

For further information

Contact the Foundation for environmental education in France (Feee), Secretariat 'Jeunes reporters pour l'environnement', 127, rue de Flandres, 75019 Paris, France.

A 50 page report on the ozone project 'synthèse du projet ozone' is available in French at the above address.

About the author

Philippe Saugeir is the Chargé de mission Feee and can be contacted at address above.

Measuring ozone in the atmosphere

100 km from Kiruna is a little town called Abisko – the site of a Swedish scientific research centre. This centre is connected to the EASOE campaign – the European Arctic Stratospheric Ozone Experiment. The use of a 1 metre telescope (photo above) is helping to measure, among other things, the amount of ozone in the atmosphere.

When light enters the telescope it hits some large mirrors, which reflect the light onto a smaller mirror, which again reflects the light into a little hole at the end of the large mirror. Behind this hole there is a spectrometer, which divides the light into its different wavelengths which subsequently get measured. On the side of the telescope, there is a hole through which scientists can look through to find the star whose light they wish to measure. In a building nearby, 2 computers follow the measurements – one to control the telescope's direction to track the star, the other to collect the data from the telescope. Using known information about the star's spectrum outside the atmosphere, and known information about the different levels of light absorption for the elements in the atmosphere, scientists can calculate the content of ozone and other gases in the atmosphere. Two types of stars are used in their measurements – hot stars (12000 kelvin) and cold stars (6000 kelvin) because hot stars have most of their light in the blue part of the spectrum, and cold stars have most of their light in the red part of the spectrum. In this campaign, hot stars are usually observed because UV light is in the blue part of the spectrum.

This information is an extract from an article by Anders Poulsen, provided by Philippe Saugeir, Chargé de mission, Feee.

The cartoon comic in French on the next page was developed by one of the students participating in the Foundation for environmental education in Europe (Feee) program 'Young reporters for the environment'.
LA COUCHE D'OZONE
par le professeur Eugène Mortibus

En effet, sous leurs actions, les molécules de CFC sont AMPUTÉES d'une molécule de chlore !

Aussitôt les molécules de chlore sont EMPRISONNÉES, par une molécule de NOx.

Mars les nuages STRATOSPÉRIQUES les libèrent rapidement.

le chlore va aussitôt attaquer les molécules d'ozone...

... qui explosera en deux parties...

... et le chlore rentrera à la base...

... le CFC a retrouvé son pouvoir destructeur...

... et va détruire ainsi plusieurs autres molécules d'ozone, ZNK! ZNK!!
**What is the Secret of Life?**

WGBH-TV will present *The Secret of Life*, an eight-part series premiering on public television stations nationwide in the United States in fall 1993. (Check with your local PBS station for exact airdates and times). The series, known as *Life: Cracking the Code* in the United Kingdom, will also be broadcast on BBC-TV.

Hosted by geneticist and television personality David Suzuki, this series explores the "new biology" for both scientists and non-scientists and defines the moral, financial and political implications of this new technology.

To extend the educational impact of the series, WGBH is offering free print materials for science and social studies teachers. A 32-page secondary school teacher's guide, with activities and discussion questions, will help teachers tackle the very important issues and ethical questions that the 'new biology' raises. A full-color classroom poster with reproducible hands-on activities and a special elementary school teacher's contest will help teachers introduce simple genetics concepts to elementary school students.

For more information, please contact:

Marisa Wolsky  
Outreach Coordinator, WGBH  
Educational Print & Outreach  
125 Western Avenue  
Boston MA 02134  
Tel (617) 492-2777, extension 4390  
E-mail: MARISA_WOLSKY@WGBH.ORG

The Secret of Life will have 7-day off-air taping rights.

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**NEW ICASE PUBLICATION**

**Empirical Research in Chemistry and Physics Education**

**Proceedings of the International Seminar**  
**10-12 June 1992**  
**University of Dortmund, Germany**

Edited by  
Hans-Jürgen Schmidt

This new ICASE publication contains the papers presented at the International Seminar on Empirical Research in Chemistry and Physics Education held at the University of Dortmund, Germany, June 10-12, 1992. The papers reflect very different research methods. Titles include:

*Dale R Baker*  
Learning science; insights from research on teaching and assessment

*Robert W Fairbrother*  
Criterion-referenced assessment: a case study of the English National Curriculum

*Myra L Halpin*  
Strategies students use to solve chemistry problems

*Hanno van Kuehen*  
The educational structure of organic synthesis

*Gerhard Meyendorf*  
Students' abilities in working with chemistry textbooks

*Michael D Pihurn*  
Meta-analytic and multivariate procedures for the study of attitude and achievement in science

*Iris Pigeot*  
Correlation and causality

*Peter van Roon*  
'Work' and 'Heat' in teaching thermodynamics

*Elisabeth Schach*  
Methodological aspects of University of Dortmund studies of students' conceptions of chemistry

*Amos A M Shaibu*  
A study of the relationship between conceptual knowledge and problem-solving proficiency

*Rodney B Thiele & David F Treagust*  
Analogies in senior high school chemistry textbooks: a critical analysis

Copies can be ordered from:

Dennis Chisman, Honorary Treasurer, ICASE  
Knapp Hill, South Harting  
Petersfield GU31 5LR, UK

34
## Publications List

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ICASE is keen to arrange regional or world events for the benefit of member associations. If your association or organisation is interested in hosting an international seminar, workshop or conference, contact the Executive Secretary or your Regional Representative. To gain ICASE endorsement, the meeting must be international in nature, open to member associations, and, while all sectors of the science education community should be encouraged to participate, must be relevant to classroom teachers.

**1993**

**June 27 - July 3**

**VII Pacific Science Inter-Congress**  
Location: Okinawa Convention Center, Okinawa, Japan  
Contact: VII Pacific Science Inter-Congress, c/o Section of International Affairs, University of the Ryukyus, 1-Senbaru, Nishihara, Okinawa, 903-01, Japan  
The Symposia will be organised around the theme *The Pacific: Crossroads for Culture and Nature* and subthemes (1) Cultural Interchange among Pacific Peoples; (2) Speciation, Dispersal and Conservation of Species in the Pacific; (3) Towards Appropriate Technologies and Policies for Development and for the Conservation of Natural Environments in the Pacific. Scientific sessions organised by the Scientific Committees of the Pacific Science Association focus on a range of science disciplines and issues, including Science Communication and Education.

**July 6-10**

**Project 2000+ International Forum**  
Location: Paris, France  
Contact: Dr Jack Holbrook, Project 2000+, Science and Technology Education Unit, UNESCO, 7 place de Fontenoy, 75352 Paris 07SP, France  
This worldwide conference, organised by ICASE in conjunction with Unesco and other international bodies is the second phase of the three phase Project 2000+. The theme of the forum addresses the issue of Scientific and Technological Literacy for All. Sessions will establish agendas for future action. Attendance will be by invitation only. The forum plans to issue statements to affect political visibility for science and technology education for all as a requirement for national development, and provide a framework for major programs of action in science and technology education involving governments, IGOs and NGOs.

**July 8-11**

**ASERA 93**  
Location: The University of New England, Lismore, NSW, Australia  
Contact: Keith Skamp, Conference Convenor, ASERA 93, Centre for Education, UNE - Northern Rivers, PO Box 157, Lismore, NSW Australia, Fax 066-221-833  
The Australasian Science Education Research Association (ASERA) invites all those with an interest in science education research, including primary and secondary teachers and teacher educators to participate in the 24th Annual Conference of ASERA.

**July 28 - August 11**

**London International Youth Science Forum**  
Location: London, UK  
Contact: LIYSF, PO Box 159, London SW10 9QX, UK  
The Science Forum is the principal annual meeting in Britain of young scientists. Over three hundred students attend from some fifty nations to make this an international event of major significance. The program features lectures, seminars and demonstrations from leading scientific names, and an extensive range of visits to university and industrial research establishments.
July 19-24
International Conference of Physics Education on Light and Information
Location: Braga, Portugal
Contact: GIREF 1993 Conference Local Committee, Universidade de Minho, 4719 Braga Codex, Portugal
The conference is sponsored by the International Union of Pure and Applied Sciences (IUPAC), the International Group for the Advancement of Physics Teaching (GIREF), the European Physical Society (EPS) and Sociedade Portuguesa de Fisica.

July 31 - August 5
Gender and Science and Technology Conference: GASAT 7
Location: Waterloo, Ontario, Canada
Contact: Ann Holmes, GASAT 7, Ontario Women's Directorate, 480 University Avenue, 2nd Floor, Toronto, Ontario M5G 1V2, Canada
GASAT's seventh conference is entitled 'Transforming science and technology: our future depends on it'. GASAT provides a forum for individuals and organisations concerned about the inclusion of girls and women in the world of science and technology, from early childhood to work environments. Four areas focus on: (1) recruitment and retention of girls and women in science, engineering and technology; (2) developing a feminist perspective on science that recognises the diversity of experiences of women, girls and indigenous peoples; (3) creating a more inviting climate for work and study, and developing strategies for change; (4) gender sensitive science, engineering and technology curricula.

August 15-20
34th IUPAC Congress
Location: Beijing, China
Contact: Prof Xinqi Song, Secretary-General of 34th IUPAC Congress, c/o Chinese Chemical Society, POB 2709, Beijing 100080, China, Fax 86-1-256-8157
The Congress is being organised by the Chinese Chemical Society, sponsored by the International Union of Pure and Applied Chemistry (IUPAC) and supported by a number of scientific organisations in China. The program features plenary lectures and invited lectures from key scientists and educators around the world, addressing the following topics: (1) life science and organic chemistry; (2) chemistry for a better environment and analytical chemistry; (3) chemistry of advanced materials and inorganic chemistry; (4) new polymer materials and macromolecular science; (5) petrochemistry, fossil fuels chemistry and catalysts; (6) physical chemistry; (7) chemical information and computers in chemistry; and (8) popularisation and education of modern chemistry.

August 26-31
WOCATE 93 International Conference
Location: Northern College, Aberdeen, Scotland
Contact: Carole Thomson, Conference Director, Science & Technology Department, Northern College, Aberdeen Campus, Hilton Place, Aberdeen, Scotland AB9 1FA
The World Council of Associations for Technology Education will hold WOCATE 93, the Festival of Technology Education for Elementary Stages (ages 5-14). This conference will focus on: Technology education as an indicator of humanistic education; Innovation in curriculum developments and teaching materials; Technology education in the process of developing attitudes, values and social relations; Technology education and its potential for developing children's thinking; Developments in the initial and continuing education of teachers for technology education.

September 6-16
Science, technology and society - appropriate science education for the twenty first century
Location: Department of Educational Studies, University of Oxford, UK
Contact: Your local British Council office, or Courses Department, The British Council, 10 Spring Gardens, London SW1A 2BN, UK, Fax +44-71-389-4154
There are vacancies for 30 participants to focus on the following issues: (1) the nature of STS as education; (2) objectives and the evaluation of courses; (3) information knowledge and public understanding of science; (4) industry and STS; (5) STS in developing countries; (6) law, values and decisions about the environment; (7) new curriculum materials; and (8) teachers and in-service education. The seminar is intended for experienced science teachers, educationists, and government officials involved with curriculum planning and implementation and inservice work with teachers. The seminar fee, including accommodation, is £1440.

September 11-14
2nd European Conference on Research in Chemical Education
Location: Pisa, Italy
Contact: Dipartimento di Chimica e Chimica Industriale dell'Università di Pisa, via Risorgimento, 35, 56126 - Pisa, Italy, Fax 050-918-260
This conference aims to describe the state of chemical education research and to help chemists develop this research, and develop a European cooperation for the defence and promotion of didactics. Topics include representations and conceptions, evaluation, trends in didactics, problem solving, experimental teaching, computer assisted teaching, new technologies, and chemistry and the environment. Languages of the conference will be English and Italian.

November 22-27
Asian Workshop on Global Change Education
Location: Madras, India
Contact: Prof R R Daniel, Scientific Secretary, Committee on Science and Technology in Developing Countries (COSTED), 24 Gandhi Mandap Road, Madras 600 025, India
COSTED, because of its interest in the promotion of environmental education in developing countries, is considering an evaluation of the suitability of the materials on Global Change produced by ICSU-CTS to meet the needs
of teachers and students of the developing world. Participation is by invitation only (refer to article in the section Science Education Around the World).

1994

January
ASE Annual Meeting
Location: UK
Contact: Annual Meeting Secretary, ASE Headquarters, College Lane, Hatfield AL10 9AA, UK
Full details of this large international event will be circulated in Education in Science, a journal of the Association for Science Education.

July 27 - August 10
London International Youth Science Forum
Location: London, UK
Contact: LIYSF, PO Box 159, London SW10 9QX, UK
The Science Forum is the principal annual meeting in Britain of young scientists. Over three hundred students attend from some fifty nations to make this an international event of major significance. The program features lectures, seminars and demonstrations from leading scientific names, and an extensive range of visits to university and industrial research establishments.

August 8-12
13th International Conference on Chemical Education
Location: San Juan, Puerto Rico
Contact: Ram S Lamba, Chairman 13th ICCE, Inter American University of Puerto Rico, PO Box 191293, San Juan PR 00919-1293
This will be the first time that an ICCE meeting will have been held in the Caribbean Region. The objective of this conference is to bring together chemistry teachers from the pre-college and college levels to share ideas and learn from each other about innovations in the teaching and learning of chemistry. The theme is 'Chemistry: The Key to the Future'. The Conference will feature plenary lectures, symposia, lecture presentations, workshops, poster sessions and exhibitions. Scientists and science educators from around the world will report their work.

1995

July 26 - August 9
London International Youth Science Forum
Location: London, UK
Contact: LIYSF, PO Box 159, London SW10 9QX, UK
The Science Forum is the principal annual meeting in Britain of young scientists. Over three hundred students attend from some fifty nations to make this an international event of major significance. The program features lectures, seminars and demonstrations from leading scientific names, and an extensive range of visits to university and industrial research establishments.

August 24-31
7th International Symposium on World Trends in Science and Technology Education
Location: De Koningshof, Veldhoven, The Netherlands
Contact: Secretariat 7th IOSTE symposium, PO Box 2041, 7500 CA Enschede, The Netherlands
Symposium presentations will be organised around at least three cross-curricular areas of interest: (1) science/technology related social issues including environment, health, peace, third world development, risk and safety; (2) further education and employment including career orientation, career preparation; (3) teaching methods include fieldwork, cross-curricular projects, computer simulations. Proposals for these and other topics are invited that report/reflect on research, practical experience or innovations relating to the main theme of 'Science and Technology Education in a Demanding Society'.

August 25 - September 1
International Conference on Industry-Education Initiatives in Chemistry
Location: University of York, UK
Contact: Miranda Mapleton, Chemical Industry Education Centre, Department of Chemistry, University of York, York YO1 5DD, UK, Fax +44-904-432516
This international conference is co-sponsored by the International Union of Pure and Applied Chemistry (IUPAC) Committee on Teaching of Chemistry, and the Royal Society of Chemistry Education Division and Industrial Division.
International Forum

Scientific and Technological Literacy for All

Phase 2 of Project 2000+

Paris, France
6-10 July 1993

This International Forum is the Second Phase of Project 2000+, an international project on scientific and technological literacy for all, which addresses the following 6 focus areas:

1. The nature of, and the need for scientific and technological literacy
2. Scientific and technological literacy for development
3. The teaching and learning environment for scientific and technological literacy
4. Teacher education and leadership for scientific and technological literacy
5. Assessment and evaluation for scientific and technological literacy
6. Non formal and informal development of scientific and technological literacy

Attendance will be by invitation only and limited to participants representing:

- National EFA (Education For All) Groups
- National policy makers overseeing science and technology education
- INISTE centres
- Project coordinators and field workers for organisations
- Science and technology teacher associations
- Institutions, centres, universities and colleges involved in science and technology curricula, examinations and teacher education
- Science and technology out-of-school centres and organisations
- Non formal science and technology educational organisations
- Industrialists
- Persons from the mass media interested in Project 2000+

There will be a US$100 Registration Fee for each participant to help defray material costs. This will be payable to the Project 2000+ Secretariat on receiving the invitation. For further information, contact:

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Science Education International is the Quarterly Journal of the International Council of Associations for Science Education. ICASE was established in 1973 to extend and improve education in science for all children and youth by assisting member associations throughout the world.

This journal provides a means for associations, institutions, centres, foundations, companies and individuals concerned with science education, to share perspectives, concerns, ideas and information which will foster cooperative efforts to improve science education, and which will serve as a chronicle of the advancement of science education throughout the world.

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Dates for Receipt of Contributions

<table>
<thead>
<tr>
<th>Issue</th>
<th>Closing Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>March</td>
<td>1 February</td>
</tr>
<tr>
<td>June</td>
<td>1 May</td>
</tr>
<tr>
<td>September</td>
<td>1 August</td>
</tr>
<tr>
<td>December</td>
<td>1 November</td>
</tr>
</tbody>
</table>

ICASE News

Feature Articles
Declaration of Project 2000+ International Forum
Language Problems in Learning Science  A Sharp
Linking Science Education and Research  J R Percy
Teaching Science in an Artistic Way  J E Nesbit

Science Education Around the World

Research on Teaching and Learning
Chemistry in the Community CHEMCOM:
Description and Evaluation  F X Sutman & M H Bruce

Science Teacher Education
The Bolivia Instructional Enrichment Partnership  J E Pedersen

Primary Science
Water Molecules in Motion  Z Z Kavogli

Science Technology Society
The Scientific Work Experience Program  S S Gottfried

Resources

Calendar

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International Forum on Scientific and Technological Literacy for All
A Report on Phase 2 of Project 2000+

The Project 2000+ International Forum was formally opened on Tuesday 6 July 1993 by Mr Frederico Mayor, Director-General of UNESCO. Mr Mayor welcomed more than 450 participants who had come from more than 90 countries. They included representatives of other United Nations agencies and international governmental bodies and a large number of non-governmental organisations.

In his opening remarks Mr Mayor emphasized the fact that the Forum provided a unique opportunity to reflect on the many issues related to scientific and technological literacy and to put forward suggestions for action to be taken at the regional, subregional and national levels.

The Forum was also addressed by Mr Georges Laforet, Doyen of the Inspection Général of the Ministry of Education who welcomed participants on behalf of the Government and people of France. He recalled the special importance attached by the government and ministry to the need for education to provide for all citizens to be enabled to participate in and share the benefits of a culture which embraced not only its rich heritage but also extremely important scientific and technological components.

The International Forum was co-chaired by Mr Colin Power, Assistant Director-General for Education at UNESCO, and Mr Bob Lepischak, President of ICASE. In his introduction to the work of the Forum, Mr Power drew attention to the declared objective of Project 2000+ to mobilise support worldwide in concerted efforts to bring scientific and technological literacy within the reach of all, particularly the young, and women and girls.

Following the opening plenary sessions the work of the Forum continued in six Focus Areas Groups:
1. The nature of and the need for scientific and technological literacy;
2. Scientific and technological literacy for development;
3. The teaching and learning environment for scientific and technological literacy;
4. Teacher education and leadership for scientific and technological literacy;
5. Assessment and evaluation for scientific and technological literacy;
6. Non-formal and informal development of scientific and technological literacy.

The conclusions reached by these groups, which are contained in the following reports, were presented in plenary session to the Forum on the morning of Thursday 8 July. This session was also addressed by Professor T Odiambo, Director of the International Centre of Insect Physiology and Ecology in Nairobi, Kenya.

A public lecture, entitled 'The race between the school and the cradle' was given by Commandant Jacques Cousteau on the evening of 8th July.

Six regional groups (Africa, Arab States, Asia, Europe, Latin America, and Small Island States) convened on the afternoons of 7th and 8th July and on the morning of 9th July. They were invited to prepare suggestions for Phase 3 of Project 2000+ and to present their conclusions at the closing plenary session of the Forum. The Chairpersons of the Focus Area Groups formed a drafting committee to receive amendments and prepare the final text of the Declaration. Delegates accepted the Declaration (refer to this section for a full report of the text of the Declaration) at the closing plenary session on Saturday 10th July.

ICASE will continue to play a key role, together with UNESCO and other international organisations on the Steering Committee of Project 2000+, in facilitating the establishment of National Task Forces and their development of plans for projects and activities in the years ahead.

In initiating this major international event, ICASE has clearly established its capacity to carry out the charter for which it was conceived — to extend and improve education in science for all children and youth by assisting member associations throughout the world.

Several members of the ICASE Executive Committee made substantial contributions to the planning and development of Project 2000+ and the International Forum. In particular, I would like to acknowledge the superb effort by Dr Jack Holbrook, Executive Secretary of ICASE. As one of the several volunteer staff who worked with UNESCO to plan the International Forum, Jack's contribution was a particularly outstanding one.

Brenton Honeymen (Photo: left)
ICASE President
New Subscription Rates for Science Education International

Since the first issue of the ICASE Journal in March 1990, individuals and libraries have been subscribing to Science Education International.

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Photo (above): Frederico Mayor, Director-General of UNESCO, addresses the International Forum on Tuesday 6th July 1993 at UNESCO Headquarters, Paris

Photo (above): Sheila Haggis addresses the closing plenary session held on Saturday 10th July

Photo (below, second from right): Colin Power, Assistant Director-General for Education, UNESCO and co-chair of the International Forum addresses delegates
ICASE General Assembly Elects New Executive Committee

The 6th ICASE General Assembly was held in two parts. Prior to the International Forum, representatives of member associations presented reports on their activities. These are reported in this issue in 'Science Education Around the World'.

At the second part of the General Assembly, held following the International Forum, a new Executive Committee was elected.

Officers elected at this meeting were:

**President:** Brenton N Honeyman (Manager, Education & School Programs, The National Science and Technology Centre, King Edward Terrace, Canberra ACT 2600, Australia)

**President Elect:** M Anna Garner (President, Félag Raunagreiksnar, Lagunafi 7, 108 Reykjavik, Iceland)

**African Regional Representative:** I O Ileobi (Federal Ministry of Education, Science Education Division, PMB 12573, Victoria Island, Lagos, Nigeria)

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**Latin American-Caribbean Regional Representative:** To be appointed

**North American Regional Representative:** Dr Kenneth R Roy (Director of Science, Glastonbury Public Schools, 330 Hubbard Street, Glastonbury CT 06033, USA)

The position of Past President was assumed by R (Bob) Lepischak (Neepawa Area Collegiate, PO Box 430, Neepawa MB, Canada R0J 1HO) following his four year term as President of ICASE from 1989-93.

At the first meeting of the new Executive Committee, the constitution requires that the above members appoint a number of officers. Those appointed are as follows:

**Executive Secretary:** Dr Jack B Holbrook (72B Blue Sea House, 28th October Street, Limassol, Cyprus)

**Honorary Treasurer:** Dennis G Chisman (Knapp Hill, South Harting, Petersfield GU31 5LR, UK)

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In addition to these appointments, ICASE welcomes the nominations of key international bodies to membership of the ICASE Executive Committee, as follows:

**UNESCO Representative:** Mr Emmanuel Apec, France

**ICU-CTS Representative:** Prof David Waddington, UK

Special thanks to retiring members of the Executive Committee

At the General Assembly, Dr Winston King of Barbados concluded his term as Past President (he was President during the years 1985-89). The incoming President, Brenton Honeyman acknowledged the valuable role and contributions that Dr King had made during his long association with ICASE, during which many new ventures and programs had become established.

Dr Jan Hendriks retired as European Regional Representative following a most active four years during which the European region had grown not only in membership numbers but, as a significant development, in establishing closer links with industry. Jan Hendriks has been instrumental in establishing a series of Industry-Education Seminars in the region — adding to the other very important meetings and seminars promoted through ICASE in the region. The President, Brenton Honeyman, commended Jan Hendriks on his initiative, energy and skill which had led to substantial developments in the European region.

Dr A M Shariuddin of Bangladesh, who had been the Asian Regional Representative, stepped down at the General Assembly. The Asian Region is a particularly active region, and the President acknowledged Dr Shariuddin's contributions to ICASE during his term of office.

Ms Althea Maud of Trinidad, has completed her two terms as Caribbean-South American Regional Representative. As a very keen supporter of ICASE and science teacher associations in the region, she has made a fine contribution over the past 8 years in this capacity. The President paid tribute to her very valuable contribution to ICASE in the region.
Distinguished Service to Science Education
Award presented to Dennis Chisman

This citation was read by the ICASE President, Mr Bob Lepischak, in recognising the contribution of Dennis Chisman, Honorary Treasurer of ICASE, to science education. The Award was made on the occasion of the ICASE General Assembly held at UNESCO Headquarters in July 1993.

"Dennis Chisman was born in Leeds, Yorkshire, an only child of a teacher father... these roots have directed him to a life of dedication to improving and enhancing education.

"A family move to London at an early age afforded Dennis the opportunity to attend a blue ribbon grammar school where he continued his academic career and was flattered by a young lady who commented that his moves on the ballroom floor were as smooth as his manner and conversation... the young lady, Sheila, was to become his bride and wife of many years.

"At Kings College, Dennis studied Chemistry, then taught Chemistry as Head of Science at a grammar school in Richmond. Along with excellence in instruction, Dennis organised science exhibitions which motivated students and served as professional development activities for fellow educators.

"He loved teaching and fully intended on continuing with instruction as a life long career until his curiosity was aroused by a newspaper advertisement inviting applications for a new post of Education Officer at the Royal Institute of Chemistry. This opportunity gave Dennis a new career in the 'wider world' of education. A second international career opportunity came to Dennis when he was appointed Chief Education Officer of The British Council. This enabled Dennis to stamp his personality on another new challenge. Work with The British Council afforded opportunities to network with educators throughout the Commonwealth.

"In 1973 Dennis took an active role in the establishment of ICASE at the University of Maryland which hosted an International Integrated Science Conference. ICASE was to begin the work of facilitating information exchange among science teacher associations worldwide.

"Dennis was appointed Executive Secretary Treasurer of ICASE and arrangements were made to launch an ICASE Newsletter. He guided the Association through a ten year period which saw a global membership base develop, many publications printed for science educators, regional conferences planned worldwide, the human resource base of ICASE expand... due in most part to the efforts of the man who seemed to know people all over the global community, always remembering their faces, affiliations, names and spellings of their names — even if they were as challenging as Uzwynshyn.

"From 1985 to the present, Dennis has continued to support the work of ICASE as Honorary Treasurer... a challenge in these years of the lightening pound, the faltering franc, and the dwindling dollar.

"One would never guess that Dennis has been 'retired' for nearly 12 years. He continues to act as an international science consultant who has worked extensively in Africa, the Near East, the Far East, and most recently in the new Eastern Europe.

Part of a less than relaxed retirement sees Dennis watching sports like soccer and cricket which he avidly pursued for years, listening to piano music (which he could be playing if he had not been so busy as to keep him away from the piano bench), and supervising Sheila's work of enhancing and beautifying their country estate — truly an English country garden.

"Dennis, it is today a singular pleasure to speak on behalf of science educators worldwide and, on behalf of this global network, to honour you with this award of Outstanding Service to International Science Education 1973-1993. I join colleagues and friends who stand in your shadow and applaud your contributions to the global science community.

Photo (below): Dennis Chisman receiving his award from Bob Lepischak in Paris during July
PROJECT 2000+

International Forum
Scientific and Technological Literacy for All

DECLARATION

At the conclusion of the International Forum on Scientific and Technological Literacy for All held at UNESCO Headquarters, Paris, 5-10 July 1993 (refer to the report on page 2-3), more than 400 participants from more than 90 countries endorsed the following declaration.

We, participants in the Project 2000+ Forum meeting at UNESCO, Paris, France from 5-10 July 1993:

1. Recalling the World Declaration on Education for All, in particular its recognition that ‘sound basic education is fundamental to the strengthening of higher levels of education and of scientific and technological literacy and capacity and thus to self-reliant development’ and, further recalling recent worldwide expressions of concern for the environment and for the quality of human life, especially those contained in Agenda 21, the output of the United Nations Conference on Environment and Development, Rio de Janeiro, 3-14 June 1992,

2. Believing that scientific literacy and technological literacy are essential for achieving responsible and sustainable development,

3. Declare our full commitment to the promotion of science and technology education for all in keeping with the World Declaration on Education for All, and our readiness to contribute through Project 2000+ to the concerted action set out in the Framework for Action to Meet Basic Learning Needs;

4. Call on governments, industry, public and private sector interests, and education and other authorities in all countries to:

(a) review critically existing provisions for science and technology education at all levels and in all settings with the aim of giving appropriate attention to development and maintenance of learning programs responsive to the needs of individuals and communities;

(b) assign priority to the development and introduction of programs leading to scientific literacy and technological literacy for all with the aim of achieving responsible and sustainable development;

(c) take such steps as may be necessary to ensure equity of access for everybody to science and technology education, notably for women and girls, young children and other under-represented groups;

(d) develop appropriate in-school and out-of-school opportunities, programs, curricula and assessment procedures for science and technology education responding to the human needs of a scientific and technological society;

(e) ensure and support appropriate pre-service and continuing in-service provisions for those responsible for all forms of science and technology education;

(f) encourage and support evaluation, research and development in science and technology education in both formal and non-formal sectors;

and to this end:

(g) establish and support task forces involving partnership with public and private educational bodies and councils; these might include universities and other institutions of higher and further education, research institutions, libraries, interactive science centres, environmental areas and nature reserves as well as public and private bodies active in the fields of agriculture, natural resources, environment, health, industry, commerce and the media, and also organisations and individuals especially concerned with science and technology education;

(h) recognise the central role of teachers in achieving scientific literacy and technological literacy for everybody, and enhance the status of careers in science and technology education at all levels;

(i) recognise the capital role of institutions of non-formal education, such as museums and scientific centres, of the media (radio, television and the press) and of all other out-of-school channels for communicating knowledge of science and technology, in fostering scientific and technological literacy for all; and

develop activities designed to set science and its applications in a wider social and cultural environment;

(j) ensure that adequate resources are available to achieve these aims;

5. Urge United Nations Agencies and other inter-governmental organisations to work together to initiate and support programs which will advance the ability of countries and of populations to shape their own future in a scientific and technological society and which will increase the capacity of countries for designing, planning and implementing scientific literacy and technological literacy programs;

6. Urge non-governmental organisations active in fields of science and technology education, as well as the social sciences, and professional associations of teachers and educators and educational organisations at all levels to:

enter into partnership with, and make their knowledge and experience available to, United Nations and other inter-governmental bodies as well as establish innovative programs in a common effort to achieve the goal of scientific literacy and technological literacy for all; and
participate in national, regional and international programs for the enhancement of scientific literacy and technological literacy for the improvement of the quality of life in all societies and for the achievement of sustainable development;

7. **Recommend** that UNESCO makes provision, within its Medium Term Plan (1996-2001) in the field of education, and in the context of Project 2000+, for an international program to develop co-operation among all countries in the field of science and technology education, with particular reference to the promotion of scientific literacy and technological literacy for all:

- **(a)** understanding of the nature of, and the need for, scientific literacy and technological literacy in relation to local culture and values and to the social and economic needs and aspirations of each country and its peoples, and also in accord both with the general aims of education for the all-round development of human personality and with human rights and basic freedoms;

- **(b)** identification of those issues concerning the applications of science and technology which are of special importance for personal, local and national development and their embodiment in educational programs;

- **(c)** establishment of teaching and learning environments as well as supporting structures conducive to the achievement of scientific literacy and technological literacy for all;

- **(d)** formulation of guidelines for the preparation and continuous professional development of science and technology educators and leadership coupled with assistance to countries in giving effect to them;

- **(e)** development of effective communication, both verbal and visual, assessment strategies and evaluation programs designed to enhance general levels of scientific literacy and technological literacy;

- **(f)** support for the non-formal and informal sector in its own right and support for development strategies which will help to stimulate and maintain lifelong scientific literacy and technological literacy;

8. **Recommend** that by the year 2001 there be in place appropriate structures and activities to foster scientific literacy and technological literacy for all, in all countries.

---

*Photo (above): Madame Sheila Haggis, Chief Rapporteur for the Project 2000+ International Forum, addresses the final plenary session.*

*Photo (above right): Presiding over the final plenary session are (L to R) Prof. Samuel Bajah of the Commonwealth Secretariat; Mr Emmanuel Apea of UNESCO; Mr Colin Power, UNESCO Assistant Director General for Education; and Mr Bob Lepischak, ICASE President. Mr Power and Mr Lepischak co-chaired the Forum.*

*Photo (right): Delegates at the final session endorsing the Declaration.*
The following is a brief survey of some of the most common features of scientific language, the recognition of which will enable the teacher to design exercises to assist learners better develop their understanding and learning of science.

Scientific language usually avoids personal styles and common words and has a formality of register which school pupils may not encounter in their study of narrative prose – so often the only diet of English language classes. In recent years the relatively new science of linguistics has been analysing the nature of scientific language and has shown it has a specific structure with its own characteristics. Learners may experience difficulties with conceptual problems or the use of technical words, but linguistic studies have revealed that technical words make up only a small percentage of scientific texts (Hoffman 1981, Inman 1978) while the linguistic features of scientific English create a much more significant barrier to learning.

The Language of Science

The language of science will usually show more frequent use of the following features:

• Academic Vocabulary: Words such as tangible, simultaneous, potential, establish, fundamental, function, verified. Many of these words are unlikely to be part of the learner’s everyday language.

• Passive forms of the verb may cause more difficulty than active forms: The litmus paper is placed (passive verb) in the liquid is more difficult than Place (active) the litmus paper in the liquid (Carroll 1986, 41-42 et al).

• Complex nominal compounds: The day and night weather observation station. A low cost diesel engine transmission unit. Complex nouns of this sort feature strongly in science texts.

• Compound Words: Another aspect which might be considered is the need to be able to interpret new words by breaking them into component parts, for example; poly many quadrilateral side epi on the upper surface meso middle of structure. A poly gon of four sides is called a quadrilateral. A leaf is covered by a single layer of cells called the epidermis which forms the skin. Between the upper and lower epidermis is the mesophyll. Direct teaching of word parts such as these will give clues to meaning of a variety of words in context.

• Modals: ie may, could, should, would, etc. Correct and exact use of these words need practice.

• Tenses: There may be confusion over the precise implications of the tenses used, viz The material burns. The material is burning. The material has burnt.

• Sentence length: Complex sentences will require the reader to scan backwards and forwards to pick out subjects and verbs.

Fluoridation is the addition of chemical a chemical called fluoride to a town’s water supplies to reduce tooth decay. Fluoride occurs naturally in the drinking water of some towns and for many years scientists have been aware that people living in such areas suffered from less dental curies than those whose water supplies did not contain any.

• Comparison and contrast: X and Y are similar/different. X is virtually/precisely/approximately the same as ...

• Cause and effect: If X then Y ... If a match is inverted the flame becomes larger.

• Definition and generalization:

Definition:

An ammeter is an instrument which measures electrical current

term class special features

Generalization: Ammeters measure electrical current

• Classification: Preparing classification diagrams (as shown below) will help to make the structure of a text clear.

Human teeth are of several types, each adapted to a different function. In front are the chisel-shaped incisors, four in the upper jaws and four in the lower. There are canine teeth on each side of the jaw. Behind these are three molars (in adults) and two pre-molars: these are ridged, flattened surfaces and function in grinding and pounding and crushing food. A child’s first teeth do not include those mentioned above. The first teeth are...

Teeth

milk permanent

canine incisors molars pre-molars

• Another aspect which can be considered for classroom practice is for the teacher to use what Buzan (1974) called hooks or burrs on which to hang meaning. The more connections which can be found the more improvement may
The idea here is to use language communicatively to discuss meaning which may reveal a learner's personal interpretations and misconceptions. Inviting learners to express themselves in their own words and experiences has been mentioned by others. (Carre 1981, Sutton 1992)

Learners come to understand language based on what they already know: it is necessary to encourage reflective thinking through talking and writing about experimental work.

I have presented here just a few ideas in which recent knowledge of the linguistic structure of scientific English can be used in the science classroom. The development of language support work can be done in conjunction with English department staff who, with encouragement, will recognise the importance of this language across the curriculum approach.

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About the author

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ICASE AWARD SCHEME

for outstanding contributions to international science education

Nominations for these awards must be forwarded by member associations of ICASE. For full details of how to forward nominations, contact the Executive Secretary below.

ICASE Distinguished Service Award

This award is made to individuals who have a career history of distinguished service to international science education through their involvement in the international activities of local, regional and global science education organisations.

ICASE Regional Service Award

This award honours individuals who have made a significant contribution to international science education through their involvement in international activities at the local and regional levels.

ICASE Association Award

This award recognises individuals who, within their science teacher association, have made a significant contribution to the international activity of their association.

Contact Dr Jack Holbrook, Executive Secretary ICASE
72B Blue Sea House, 28th October Street, Limassol, Cyprus
Linking Science Education and Research

by John R Percy

Until about a century ago, any intelligent person with sufficient resources could contribute to scientific research. Then science became big, complex, technical and specialized, at least in the industrialized countries. Intelligent lay people were reduced to the role of bystanders, able to watch but unable to participate actively in the excitement of research and discovery. Perhaps this is why science is no longer part of culture in countries like mine. (There is, of course, a second kind of 'research and discovery' in which an individual personally experiences the thrill of observing or understanding a phenomenon for the first time. This is an extremely important process, but not the subject of this article.)

There are exceptions. In my field of astronomy, skilled amateurs still play an important role, for instance by discovering comets, and measuring the changing brightness of variable stars in a systematic way. This work is co-ordinated internationally by the American Association of Variable Star Observers (25 Birch Street, Cambridge MA 02138-1205, USA). Could this model be applied in other branches of science as well? Certainly in the industrialized countries, there are millions of intelligent, enthusiastic people looking for stimulating ways to fill leisure time or retirement years. Involving them in original scientific research would increase direct support for science, and increase public understanding of science by bringing science and the public closer together.

The most suitable projects might be those involving surveys, interviews, routine sample collection, or measurement with simple, calibrated instruments. Volunteers could also create and maintain databases on a microcomputer, and perform simple statistical analyses. Long-term studies, or comparative studies between geographical regions or populations would be possible and worthwhile. These would be useful approaches in fields such as pollution and other environmental studies, health and nutrition, consumer studies, conservation and recycling, gardening and agriculture. These fields are not only smaller and simpler than experimental particle physics, for instance; they are also more practical, at least in the short run!

For this reason, the 'volunteer' approach might be relevant to the developing countries. There are always some bright young students in schools and universities, looking for active involvement in science. They could provide their teachers and professors with enthusiastic help in practical research projects, while learning the basic methods of science. Perhaps this would be an effective way of attracting more young people to careers in science and engineering in those countries.

Students, of course, can participate in research through science fairs, and some science fair projects are significant contributions to scientific knowledge. This tends to occur 'by accident', since science fairs are usually disconnected from the scientific community.

The University of Toronto Mentorship Program (Faculty of Arts and Science, University of Toronto, Toronto, Canada M5S 1A1) enables outstanding senior high school students to work on real research projects with university faculty members. To the student, the program offers involvement, challenge, skills development and experience. To the mentor, it offers an enthusiastic, capable assistant, and a useful contact with the school system. A disadvantage of the program is that it can only accommodate about 150 students (though if every faculty member supervised a student, it could accommodate ten times more). An alternate model would have the mentor meet with a group of students (and their teacher) two or three times a year, to guide them in a group project with sub-components for each student.

A university, science centre or museum could provide the infrastructure through which students (or the general public) could participate in research, matching up mentors, projects and volunteers. An alternative (or adjunct) possibility would be a local 'academy of science', such as are found in many parts of the USA. These could disseminate the results of volunteers' research through conferences and journals, giving the volunteers experience in making oral or written reports, and feedback from other researchers. The most important results could be abstracted and circulated internationally. This social and educational component of the research process is very important; volunteers should not simply be used as cheap labour.

By linking formal and informal science education with research in this way, the gap between science and society would close a bit; science would gain an army of enthusiastic supporters; and the public could experience the excitement of science – which is, after all, a human endeavour. If you are interested in linking science education and research, either in a school or public setting, I would be glad to share my experience with you.

About the author

John R Percy, Professor of Astronomy and Associate Dean (Sciences) can be contacted at Erindale College, University of Toronto in Mississauga, 3359 Mississauga Road North, Mississauga, Ontario, Canada L5L 1C6.
Sixth Edinburgh International Science Festival

Edinburgh, Scotland
7-23 April 1994

Following the success of the 1993 Festival which attracted over 200,000 people to 367 events, preparations for the 1994 Festival are now well in hand.

Major themes include
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Molecule of the day
Science myths of out time
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exhibitions, talks, debates, performances
family events, tours, conferences
and workshops including
Madlab
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FUNdamental Physics
Science Dome

Contact: Marion-Jane Pate, Assistant Chief Executive, Edinburgh Science Festival Ltd
1 Broughton Market, Edinburgh EH3 6NU, Scotland, UK

Project 2000+ International Forum

Photo (below): Three of the leaders of Focus Area Group 6 in session with 40 participants developing proposals relating to the non-formal and informal development of scientific and technological literacy, at UNESCO Headquarters, Paris, July 1993. From left to right: Jayshree Mehia (India), Cheng Donghong (China) and James Bradburne (France). The reports of the six focus area groups will be published along with recommendations arising from the six regional groups.
Teaching Science in an Artistic Way

by James E Nesbitt

From a very early age, young children have experiences with art. Although children may not be able to articulate a definition for this activity, they do have an understanding of what it means to do art. These children have already utilized artistic tools, such as scissors, construction paper, paste, and crayons. Most young children enjoy doing art and approach this activity freely and creatively.

Doing art is perceived as an activity worthy of pursuit for its own sake. Art is perceived as an expressive and creative activity that children do freely outside of the school curriculum. That is, children do art and do it well, without appealing to its association in a school context. It is even normal for children to think of art in this way.

On the other hand, few children do not perceive science in this way because science is viewed as 'practice' for what occurs later in their lives. The activity becomes disassociated from a child's everyday life. Science is seen as a disciplined activity and therefore the expressive and creative element gets lost as children sit in textbook-centred classrooms and sift through memorizable facts.

Young children are curious. They explore the world around them. They ask questions about science very early in their lives and make many attempts to understand how things work. Yet, we often wait to provide children with the 'tools of science'. Science apparatus is usually found locked behind glass cabinets in our schools. Many students, as well as adults, perceive these 'tools' as nothing more than the tools of a scientist.

Children who have an early interest in doing science have very limited access to the equipment necessary for experimentation; even experimentation on an elementary level. Therefore, any expression of science activity or idea gets reduced to improvisation, or at the other extreme, the activity does not get carried out. In a sense, this lack of access to science resources contributes to the perception of science as 'just something that we do in schools'.

If we establish a philosophy about science that de-emphasizes its 'classroom image' and its image as 'something only scientists do' and emphasize its potential as an activity engaged in for its own sake, then young children will have another context for establishing the role of science in their lives. As children experience formal science education in school, science for some of them will be perceived as a subject that is designed for the most highly skilled student. When children reach high school, this image of science becomes even more believable. The low numbers of children in upper level science courses (chemistry and physics) supports this image. According to some, only the brightest children can compete in such courses. Of course, this is not always the case. Yet, we go on believing this to be true by upholding the position that if you take chemistry and physics and 'succeed', then you are among the most talented and gifted students. As a result of these perceptions, images, and beliefs, many students decide against including science in their studies. These students avoid science. Why can't science be more like art?

Even the term 'science' may impede access, because this term, for some, denotes a field of study concerned primarily with objectivity, rigor, precision, and exactness. This connotation divorces science from its meaning for our everyday lives. It is this meaning that helps provide the validity of, or that explains the useful role of science for us.

When children perceive science as an experience detached or isolated from their everyday experiences, then the role or the usefulness of science becomes more obscure. By establishing a type of science in the minds of young children that consistently promotes relevance, we can redirect our thinking about the role of science in our lives. This relevant science should cause us to redefine the nature of science and make it consistent with our needs. The result of this type of thinking hopefully will cause individuals to perceive and experience science as a natural activity, much like art.

The appreciation expressed for art, the value placed on it, and its cultural and historical significance has implications for the sciences. Science is more than practice; it has a cultural and historical component. Like art, it is an expression of one's creativity.

In art class, one does not rely on a textbook for instruction. Art does not attract only the most skillful, thereby limiting the number of individuals who will do art. Art has met the needs of most cultures. Art has representation in most cultures; therefore, a marginalization or lack of access by certain groups does not exist. Our philosophies about and the way we teach art have implications for the sciences.

Science can be taught by utilizing the tools of art and by adopting the instructional techniques employed in the art classroom. The freedom to express one's ideas or to be creative in art class is very important for young children. The hands-on, creativity approach of the art class could be utilized in science class to provide similar instruction.

Students do art within procedural guidelines that will not compromise their imagination, creativity, or resourcefulness. Art students are encouraged to conceive their ideas and mental images and then transform these concepts into real and tangible objects through media such as paper, watercolour or clay. The expression of oneself or one's ideas is a basic philosophy of art. Yet in science, we employ pre-established procedures or methodologies that sometimes leave very little
room for creativity; thus decreasing the opportunity for serendipitous discoveries.

Science is more than just a method. Yet many students are guided through their science experiences having little chance to express themselves. The very nature of children suggests that they love hands-on activities, they love to explore, and even more, they love to create.

Although children may be exposed to a philosophy that exploration, discovery, imagination, and creativity are acceptable in the science class, they may actually be the recipients of science which minimizes these attributes. Limitations imposed by the instructor, by the use of the textbook, or even the laboratory manual can undermine a child’s curiosity and minimize the potential that a science experience can offer. We provide students, many times, with well-intended prescriptive science activities, thus sending forth a message that there is a proper or exact procedure to be followed which will provide us with exact results.

In reality, practicing scientists employ different procedures and methods to arrive at intended, as well as unintended, results (Knorr-Cetina, 1981). Yet, we teach science as if it were pure and objective with prescribed, orderly steps to be followed. Granted, structure must exist within the discipline, but it should not hinder curiosity or creativity in the classroom.

Before becoming engaged in a science activity, students should be encouraged to conceive and articulate their understanding of an activity; they should verbalize their procedure or method, as well as their expected results. This visualization could be compared to an artist who creates his or her mental images of a painting or sculpture before beginning to work. A science activity will offer more understanding and will bring to bear misconceptions about science when students formulate and articulate their own way of thinking or understanding about the activity, process, problem, or principle. Their understanding of the activity allows for an expression of themselves. They become a part of the activity, much as an artist becomes a part of his or her painting and the painting becomes a part of the artist. This opportunity creates an essence, making the experience more meaningful.

The intensity, energy, and concentration observed in artist at work is a result of the artist being occupied or absorbed in something that symbolizes a part of the artist. A similar commitment can be made by the science student, when he or she participates in a science class that provides the opportunity for self-expression. If this occurs then there is a greater likelihood that students will become adults still interested in science.

Reference


About the author

Dr James E Nesbitt is a Visiting Assistant Professor in the School Mathematics and Science Center at Purdue University, West Lafayette, Indiana 47907-1442, USA.
Member associations and individuals are invited to contribute to this section. Suitable items include brief accounts of specific projects of international significance, science education in a particular country, or international and regional seminars and conferences.

SCIENCE TEACHER ASSOCIATION REPORTS
ICASE General Assembly
Paris, July 1993
Compiled by John E Penick, ICASE Special Project Officer

Asian Region
Delores Hernandez of the Philippines presented a brief overview of activities in the Asian region, and introduced representatives of regional science teacher associations.
Anna Poedjiadi of Indonesia reported that there is a new Indonesian Association for Science Education (IASE) which involves science teachers and teacher educators. They have sponsored two symposia on science and mathematics research in 1990 and 1992, and have commenced a journal. IASE is an affiliate of the Indonesian Education Association.
Choi Kuen Or of the Hong Kong Association for Science and Mathematics Education (HKASME) reported that association membership is about 700. Many in Hong Kong are leaving teaching for the private sector. HKASME has recently revised and re-started their journal. They now also conduct monthly programs relating to various disciplines and grade levels. They have also organised programs and competitions for children.
Merle Tan presented the report of the Philippine Association of RECSAM Grantees. They have sponsored a number of workshops for teacher education as well as seminars for educators.
Delores Hernandez reported that the Philippine Association for Biology Education has an annual meeting and seminars. The most recent meeting focused on oceanography and marine biology – two critical concerns in the Philippines.

Christina Padolina of the Philippine Association of Chemistry Teachers reported that each year they organise a chemistry conference, and they produce an occasional newsletter.
Janchai Yingprayoon of the Science Society of Thailand, noted that the Society includes scientists and science teachers. They publish a quarterly journal in English and a magazine in Thai. Of the Society's 2000 members, about 500 are teachers. Activities include summer programs, workshops, field trips and science camps. They will be organisers of the 9th ICASE Asian Symposium to be held 6-10 December 1994 on the topic 'Equipment and Computer Applications in Science and Technology Education'.
Sujitha Dharmaratne of the Sri Lanka Association for Science and Mathematics Education, reported that SLASME now has 600 members from all levels and disciplines. They strive to promote curriculum development and teaching methods. There are annual and regional meetings as well as monthly committee meetings.
Sukanda Rajanasoothon reported for the Institute for the Promotion of Science Teaching and Technology (IPST). This governmental organisation is charged with developing and promoting science, technology and mathematics education at the school level. They are also concerned with environmental education.
Dr Abbas Alikhan representing the Kuwait Foundation for Science Education reported that the Foundation, established in 1976, is supported by a proportion of revenues from publicly held corporations in Kuwait. One of the Foundation’s goals is to popularise science through publications, clubs, translation of journals such as Scientific American, and various other programs. The Foundation also provides support for other societies related to science or technology.

European Region
Jan Hendriks, the ICASE Representative for the European Region, indicated that there are now 30 ICASE members in the region, almost half of which are company members. The region has hosted a number of symposia and conferences. Jan then introduced the representatives of member associations in the region.
David Moore, General Secretary of the Association for Science Education (ASE), reported that the ASE supports an international committee. The ASE provides a variety of journals, meetings and programs for its members. A new journal will be entitled 'Science Across Europe'. In the UK, national assessment has been a priority for several years. ASE hopes to introduce more practical investigations and meaningful practical exercises. In the UK, there is considerable interest focusing on science teaching.
Bert van Beek reported that NVON of the Netherlands now has 2000 members, almost all of whom are secondary teachers. New government regulations are mandating a number of changes, such as combining chemistry and physics instruction. They are expecting shortages of teachers in some areas, especially in the physical sciences.
Hans-Juergen Schmidt reported that MNU in Germany now has 6000 members. He would like to see even
more teachers involved. A recent inclusion of primary teachers will increase membership. Reunification has also caused many problems as the two educational systems were quite different. The regular series of educational research conferences at Dortmund has been very popular. The next conference will be held during 1994.

Alicja Wojtyna-Jodko reported on the activities of SNPPIT of Poland. SNPPIT produces a bulletin (produced in English and Polish), and organises conferences and other projects. The first annual conference focused on the environment. The second dealt with environmental protection. The third, to be held in September 1993, will focus on Microcomputers in Education. Projects involve cooperation with other organisations. Several publications are planned, including one on physics demonstrations.

Anna Garner, President of the Icelandic Science Teacher Association, reported that the association consists mostly of upper secondary teachers. The 300 members include every secondary science teacher in Iceland. Their journal is the prime means of communication, and they hold several meetings every year, each one on a theme. Meetings are organised as both a professional and social event. ISTA has also sponsored several sub-regional conferences.

Jacqui Clee, Royal Society of Chemistry in the UK, reported that the Society supports several competitions for students. In addition, they sponsor 'Chemistry at Work', exhibitions, and many career lectures and programs. Teachers can attend four-day residential industry-tours and summer school programs. They also provide summer fellowships for teachers, hands-on symposia, and written materials.

Brian Tricker of the International Association of Science Clubs reported that the IASC sponsors conferences and discussions as well as activities for students. They produce occasional publications, including a journal which has been published three times during the last ten years. Publications include descriptions of model science clubs as well as discussions of issues such as environmental protection.

Birgitta Lindh of the Swedish Association reported that the name of the association is about to be changed. The Swedish educational system is changing to provide more flexibility for pupils and teachers. Sweden has a shortage of professionals in science, mathematics and engineering. There is some concern that the new regulations will not alleviate this problem.

### African Region

Isaiah O Iokebi, ICASE Representative for the African Region, after commenting on the difficulties of communication in Africa, introduced the delegates to report on the activities of their science teacher associations.

Jophus Anamuah-Mensah of the Ghana Association for Science Teachers (GAST) reported that the association has 500 members, including primary teachers, secondary teachers and teacher educators. They hold an annual meeting and a science fair for students. They have published several books, and are involved with national testing programs. Fewer students are studying science, feeling that it is too difficult. GAST is planning on developing a special curriculum and to set up regional technology education centres in all regions; TV programs will also help by popularising science.

Gerard Mathot of the Lesotho Science Teachers Association reported that they conduct an annual competition and science fair for all levels. They are seeking to involve other southern African nations in science education activities. Many teachers are leaving for jobs in the private sector where salaries are higher.

Sikhonhla Sumbi of the Swaziland Science Teachers Association reported that SSTA is now 25 years old and currently has 200 members. The slight reduction in numbers is due to schools joining, rather than individual teachers, in order to reduce costs. SSTA sponsors science fairs with other regions and produces a newsletter. Swaziland is also experiencing an exodus of science teachers to industry. SSTA hopes to expand their horizons and be involved with other countries, gaining ideas and friends.

Emile Lisk, representing the Sierra Leone Association of Science Teachers, reported that SLAST has several projects underway. A major project is exploring the relationship of science and technology.

Dr U M O Ivowi, President of the Science Teachers Association of Nigeria (STAN), reported that STAN, formed in 1957, has grown to a membership of 1000. This includes primary and secondary teachers as well as teacher educators and others interested in science education. STAN has sponsored a variety of projects.

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If you belong to an association which is an ICASE member the card entitles you to benefits from the member association of the country you visit.

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or Dennis Chisman, ICASE Honorary Treasurer

Knapp Hill, South Harting, Petersfield GU31 5LR, UK
Jan Hendriks (Left), ICASE Representative for the European Region, introduces European delegates who presented reports at the ICASE General Assembly in Paris, July 1993.

Isaiah O Ikeobi (Right), ICASE Representative for the African Region, introduces African delegates who presented reports at the General Assembly.

Anna Garner (left), President of the Icelandic Science Teachers Association, presents her report on the activities of the association.

Kenneth Roy (right), ICASE North American Representative, introduces North American delegates who presented reports on their activities.

John Penick (left) presents his report on the activities of AEIS at the ICASE General Assembly.
including workshops in 9 different subject areas, and symposia (including a joint one with ICASE). STAN has developed an exchange at annual meetings with ASE and NSTA. The STAN executive officer is also obtaining additional training at ASE and NSTA. In addition to their journal, STAN is sponsoring several position papers on current topics such as STS.

Isaiah O Ikeobi presented a brief report on the Science Teachers Association of Malawi (STAM). Efforts are being made to revive the association.

Caribbean Region

Winston King, Past President of ICASE, reported that the Caribbean has seven science teacher associations. However, only Trinidad & Tobago and Jamaica have active organisations. Others are dormant as they are experiencing a lack of finances.

Recent events in the region include the ASSETT-ICASE Conference in 1991, and several science fairs and exhibitions.

There will be such a fair in the British Virgin Islands in August 1993. The region plans to be involved in Phase 3 follow-up to Project 2000+ during 1994-95.

Australasian-Pacific Region

Maris Sils, the ICASE Representative for this region, reported that there are now four member associations.

Since the last General Assembly, the Fiji Association of Science Teachers (FAST) has become a member following its formation in 1991. Their plans include organizing a conference, competitions and a journal.

Maris reported that the New Zealand Science Teachers Association now has an executive secretary courtesy of the Royal Society. NZSTA is developing policy statements related to publicity, commercial activity, and education. They also distribute materials and are conducting research about teachers and teaching.

The Australian Science Education Research Association is now the Australasian Science Education Research Association, a move designed to reflect their membership and mission. Primarily, they conduct research and produce papers. The ASERA Conference is a major annual event for the association.

The Australian Science Teachers Association, through expanding its full time secretariat, is becoming more visible and is helping teachers to develop a national, as distinct from a state focus. ASTA sponsors a variety of activities, competitions and meetings, including an annual conference (CONASTA) which attracts a number of overseas delegates. The UK-Australia Exchange program provides an opportunity for 10 ASTA science teachers to study in the UK, and for 10 ASE science teachers to study in Australia.

The Solomon Islands Science Teachers Association, not yet an ICASE member, is developing a resource centre and holds meetings twice a month.

North American Region

Kenneth Roy, ICASE Representative for the North American Region, introduced the representatives of North American science teacher associations.

Sylvia Ware, representing the American Chemical Society, reported that the ACS now has 148,000 members of whom 3000 are high school chemistry teachers. ACS is active in all levels of chemistry education and has an education division staff of 35. ACS offers short courses, two educational journals, and programs for all levels. School programs include curriculum work such as CHEMCOM, a very successful chemistry text designed for the college-bound but not science oriented student. CHEMCOM now has 17% of the US market. A new program FACETS is being developed for release next year. ACS also sponsors competitions and scholarships and is working to attract parents to work with their children. One aspect of this is a bi-weekly column in USA Today which includes science questions and activities for children and parents. ACS also publishes WONDER SCIENCE, a comic book for students.

John Penick reported that the Association for Education of Teachers in Science (AETS) is holding steady at 750 teacher educator members. In addition to their four regional meetings, AETS had its first annual meeting which was separate from the NSTA meeting; 400 attended that first meeting. A second meeting is scheduled for January 1994 in El Paso, Texas. AETS publishes two journals – Science Education, a general research journal, and The Journal of Science Teacher Education, which focuses more on teacher education. AETS is active in working with the National Board for Professional Standards, setting criteria for teacher licensure. AETS also reviews all proposals for accreditation of science teacher preparation programs throughout the US.

Bob Lepischak, President of ICASE, reported that the Canadian Association for Science Education (CASE) is working to overcome the problems associated with coordinating science education efforts in such a large and diverse country with a small population. CASE has recently commenced a series of national, rather than provincial meetings. CASE is now seeking to establish a permanent secretariat.

Jeane Dughi of the National Science Supervisors Association (NSSA) reported that NSSA provides leadership through a journal, newsletter, conferences and symposia. NSSA has completed a strategic plan to reflect the changing needs of members. The plan will enhance communication, collaboration and continuation of a strong science education for all.

Wendell Mohling of the National Science Teachers Association (NSTA) reported that NSTA publishes 5 journals, including one for high school students. NSTA has a membership of 49,000 and offers 3 regional conventions and a national convention each year. 30,000 teachers attended these four meetings last year. NSTA has a strong commitment to international science education, including a committee on international activities. In 1991, NSTA sponsored a meeting in Moscow where 340 Americans met with 650 Soviet science educators. In July 1993, 300 Americans are meeting with 650 Mexicans in Mexico City for another joint international conference. NSTA sponsors numerous awards (up to
As the countries of Asia Pacific draw closer together both economically and politically, it is important to raise awareness in students for one another's societies. Many of the issues faced in the environment, such as energy supply, water quality and pollution are of common concern and related to scientific problems, yet perspectives as to their causes and resolution may differ.

The Science Across Asia Pacific Project aims to:

- introduce an Asian Pacific dimension into science education by raising awareness of different perspectives, ways of life and national traditions of students in other Asia Pacific countries
- raise the awareness of the ways in which science and technology interact with society, industry and the environment
- provide opportunities to develop communication skills in the widest sense, including in languages other than their own
- provide opportunities for schools in different countries to collaborate.

Science Across Asia Pacific is publishing a series of units (packaged in two separate books) on scientific issues and providing an associated database of participating schools. The project provides a forum through which students may exchange facts and opinions with students in other countries. Australia, Brunei Darussalam, Canada, Indonesia, Malaysia, New Zealand, Philippines, Singapore, Thailand and Vietnam have already joined the project.

Book 1 includes the units: Drinking water; What do you eat?; and Using energy at home. Book 1 is available from July 1993.

Book 2 will include four units: The impact of global warming; Renewable energy; Tropical forests; and Domestic waste. These are currently undergoing trials and will be made available as Book 2 in mid 1994.

Each unit includes an introduction to the project, with maps, data, teachers' notes, student pages, and an exchange form. Each unit involves the collection of information, data and opinions. The results are combined for the whole class in order to exchange with schools in other countries. The information is usually sent by mail or fax, although the work also provides for an opportunity for linking schools by E-mail.

A unit usually takes one or two hours in the classroom and possibly a homework session to complete the preparatory work and send off the exchange forms. Another lesson is required later to discuss the information received from other schools. In addition to English, materials will be available at a later date in the national languages of Malaysia, Indonesia, Brunei, Thailand and Vietnam.

The subject matter in each unit has been carefully selected to link with, but not interfere with, existing school curricula. The level of knowledge and skills required in the units make them generally suitable for students between 14 and 17 years of age, although some teachers have also expressed interest in using them with younger students.

Experience in trials has shown that making links with students in other Asia Pacific countries is highly motivating.

For further details of how to become involved in Science Across Asia Pacific, write to:

Science Across Asia Pacific Project
Australian Science Teachers Association
GPO Box 2082
Canberra ACT 2601
Australia
Commonwealth Association of Science, Technology and Mathematics Educators

HAVE YOU ENTERED FOR A CASTME AWARD?

Contact your local British Council Office for details, or write to:

CASTME Award Scheme
c/o Education Department
Education and Science Division
The British Council
Medlock St
Manchester
M15 4AA, UK
INFORMATION SHEET

Commonwealth Association of Science, Technology and Mathematics Educators (CASTME):
Awards for science, technology and mathematics teachers 1993/94

1. Introduction

The CASTME Award Scheme was started in 1974 when CASTME (then CASME) undertook to develop the former Guiness Award Scheme. Many entries have been received over the years since it started. It is certain that some schools and individual teachers have received major professional stimulus through its activities.

The awards are intended to encourage teaching of the social aspects of science, technology and mathematics, with particular reference to developing countries of the Commonwealth. The scope of the awards is interpreted broadly, and 'social aspects' includes the relevance of science, technology and mathematics curricula to

☐ local needs and conditions
☐ the impact of technology, industry and agriculture on the local community.

2. Eligibility

Teachers and officials (advisers, inspectors, etc.) working in primary, secondary and tertiary education in Commonwealth countries are eligible to enter. Individuals or syndicates may enter.

3. Topics

There are no set topics for the competition. Reports of work carried out by the teacher or official should be based on personal experience and should include a substantial account of teaching and/or other educational work, such as curriculum development or programmes of teacher training. Entries based on ideas, proposals or general arguments which have not been tried out in practice are not acceptable.

An example of a recent prize-winning entry was entitled 'Using reed - a no-cost material - for science experiments in a rural middle school'. The author teaches in a rural school with no laboratory or commercial apparatus. The project describes how the author and students developed a wide range of experiments and investigations using reeds gathered from a nearby swamp. Examples of activity-sheets are included, links with both the environment and the prescribed science syllabus explained, and the effects of the approach described and evaluated.

Each entry must be the original work of the entrant and must not have been published previously.

4. Awards

In addition to a small money prize donated by CASTME, a few traveling fellowships are sometimes awarded at the discretion of the judges. These fellowships, a gift of the Commonwealth Foundation, enable the prize-winners to follow a short programme of professional visits in a Commonwealth country. Edited versions of all winning entries may be published in the CASTME Journal and short abstracts of winning entries are printed in The British Council's Science Education Newsletter. All prize winners will receive twelve months free subscription of the CASTME Journal. The judges are appointed by the Council of CASTME and their decisions will be final.
Judging is based on the following criteria

☐ evidence of originality and creativity

☐ evidence of use in practice and cost effectiveness (entries based on ideas, proposals or general arguments which have not been tried out are unacceptable)

☐ evidence of evaluation of the idea or material in use

☐ evidence of the social relevance of the project

☐ standards of presentation, organization and structure of the report

☐ overall impression of the report

5. Presentation of the entry

Only one entry can be accepted from any one individual or syndicate.

Entries previously submitted to CASTME may not be re-submitted.

The entry must be written or typed on A4 or quarto sheets of paper, and should not exceed 10,000 words in length. Reports in the past have mostly been between 2,000 and 5,000 words long.

Photographs and other illustrative material should be included wherever relevant, together with any other evidence that shows the ideas have been effective in practice. Pupil's work may be included when possible.

Reference should be made to the source of information or of original experiments wherever this is necessary to a proper assessment of proposed modifications.

If a substantial part of an entry is being published or submitted as a thesis, this should be mentioned on the top sheet of the entry.

6. Registration and submission

Registration must be made before 30 November 1993.

Entries from registered candidates must arrive in the Education Department, Education and Science Division of The British Council before 1 March 1994.

Intending applicants should fill in a registration form. These can be obtained from

☐ Their local British Council Office

☐ CASTME Awards Scheme, c/o Education Department, Education and Science Division, The British Council, Medlock St., Manchester, M15 4AA, UK
Chemistry in the Community
CHEMCOM: Description and Evaluation

by Frank X Sutman & Matthew H Bruce

Chemistry in the Community (ChemCom) is a year long chemistry course designed for high school students who may or may not be college bound. It is intended for that group of students who enter high school chemistry with little interest in the quantitative aspects of the subject and who have little experience in developing or applying higher order thinking skills, and who for the most part read below grade level. ChemCom was developed against a backdrop of general concern that the existing high school level chemistry texts and courses give little or no consideration to the relationships among science, technology, and societal issues. The need for school level science courses with this emphasis has been expressed in a number of national reports such as those by the National Assessment of Educational Progress (Science Report, 1975) and the American Association for the Advancement of Science (AAAS, 1988). It was developed also out of concern that existing school level chemistry texts too often merely mimic those developed for use in beginning level college chemistry courses.

ChemCom was designed to motivate students to learn chemistry by considering its applications to the resolution of societal issues. For the most part these issues are environmental in nature. An example, below, will distinguish the thrust of ChemCom from that of other high school level chemistry courses.

The chapter of the ChemCom text titled 'Petroleum: To Build or To Burn?' is introduced with a detailed presentation of the significant role of petroleum in our society. Students are challenged to assess items in their homes that are related chemically to petroleum or that are derived from petroleum. Consideration of the role of petroleum in economics through simple graphic representations is followed by a series of investigations emphasizing the 'mixture' nature of petroleum, how the components of the mixture are separated, and how certain properties of the components are related to their chemical structures. Study of the structures of 'petroleum molecules' includes a brief look at chemical bonding and isomers. An introduction to reaction mechanisms is followed by qualitative and quantitative considerations of how petroleum is used in the production of electrical energy. Heat of combustion is presented in the form of a simple investigation, including the use of basic mathematical calculations designed to support a better understanding of the mole concept. An opportunity is offered for students to read tables of data and graphs, and to interpolate and extrapolate from the graphs. The chapter concludes with a section, 'Putting It All Together', designed to involve students as a team of 'experts' who are given a set of assumptions to be applied in preparing for a public debate on the future of petroleum in our economy.

Readability Level
During the developmental stages of ChemCom the evaluators monitored the project's readability level using the Dale-Chall Readability Formula (Dale & Chall, 1948). With input from the evaluators, the final version has a readability level of grade 9, which is unique for school level chemistry texts, most of which are written at a 12th or even 13th grade level.

The Nature of the Evaluation
The formal evaluation of ChemCom was conducted by a team of independent researchers. Specific instruments were developed and validated for use in each of the four phases of the evaluation process. These four phases included:

- Phase I development and analysis of an opinionnaire related to the validity of the ChemCom objectives;
- Phase II development and analysis of the cognitive tests;
- Phase III assessment of the nature of the student and teacher populations for the field test;
- Phase IV assessment of teachers' reactions to ChemCom through an ethnographic survey.

Phase I: Initial Development and Analysis
The objectives, as shown in Table 1, are presented as questions on an opinionnaire designed to answer these two questions:

- Are the objectives developed for ChemCom valid?
- To what extent would/did this course and its use in instruction meet these stated objectives?

Note that the objectives include some that are typical of more traditional high school chemistry courses (for example, '... to learn basic chemical facts and knowledge.') and others that less
### TABLE I
Average discrepancy value between standards and performance for each objective for Chapters 1 and 2 of ChemCom

<table>
<thead>
<tr>
<th>Objective: Gives students the opportunity to...</th>
<th>Mean Discrepancy Values For the Five Participating ChemCom Groups</th>
</tr>
</thead>
</table>
| 1. Learn basic chemical facts and knowledge.  | Chapter I  
0.29   | Chapter II  
0.71 |
| 2. Understand how to deal with societal issues using chemical knowledge. | 0.31   | 0.83 |
| 3. Learn how to interpret scientific info. | 0.53   | 0.57 |
| 4. See how certain personal problems can be solved utilizing chemical knowledge | 0.70   | 0.76 |
| 5. Contains materials that are understandable to students (i.e., reading level, graphs, diagrams and scientific terminology.) | 0.45   | 0.54 |

<table>
<thead>
<tr>
<th>Objective: Helps students to...</th>
<th>Mean Discrepancy Values For the Five Participating ChemCom Groups</th>
</tr>
</thead>
</table>
| 6. Better understand the importance of acquiring appropriate scientific information before making a decision about related societal issues. | Chapter I  
0.45   | Chapter II  
0.74 |
| 7. Recognize that each solution to a complex societal problem may produce new problems. | 0.54   | 0.75 |
| 8. Identify alternative courses of action in dealing with societal issues. | 0.54   | 0.88 |
| 9. Better appreciate the scope and the limitations of science. | 0.67   | 1.08 |
| 10. Better appreciate the scope and the limitations of technology. | 0.66   | 0.92 |
| 11. Gives students opportunity to become familiar with some important issues involving interactions among science, technology and society. | 0.41   | 0.76 |

Typical, reflecting a departure from tradition (for example, "... to better understand the importance of acquiring appropriate scientific information before making decisions about related societal issues.")

### Validity of Objectives

The determination of the validity of the objectives was accomplished by comparing reactions to the stated objectives by the five groups involved in ChemCom's development. This comparison used a five point response scale and analysis of the response data utilizing the Provus Discrepancy model, a procedure that has found extensive use in social science research for similar purposes. This model assesses discrepancies among opinions held by the various participant groups regarding the appropriateness of the objectives. Results of the analysis, using the Provus model, indicate a high degree of acceptance of the objectives, with a high level of agreement across the five groups involved in the project's development, as evidenced by the fact that all group mean responses were between 4.0 and 5.0 on a 5-high scale. Based upon these results, the objectives were accepted as standards to be met by the ChemCom program.

### Meeting the Objectives

According to Provus, a discrepancy of 1.0 or less, out of a possible four, indicates a very high level of agreement regarding the acceptance of any item under question. As shown by the values in Table I, only one of 22 discrepancy values was greater than 1.0, and that only 1.08, indicating a very high degree of correspondence of the performance to the ChemCom standards. The groups that participated in the study of both the validity of the objectives and the degree to which they were met included the ChemCom Steering Committee, project administrators, authors, pilot test teachers and students.

More telling even than the above are the calculated Kendall Coefficients of Concordance and the associated probability values (p) for the agreement of performance with standards, as presented in Table II. In three of the four instances the value for p is <.001, and for the fourth, the value is <.01. These values reflect an
extremely low likelihood that the extent of agreement noted could have occurred by chance. The comparatively high p values for the two columns headed 'Discrepancy' (<.20 and <.10) support the contention of close agreement among the groups on both the validity of the objectives and the expectations for program performance.

The largest group involved in the above process was the students. Table III indicates that most of the pilot test population were enrolled in chemistry courses at the tenth and eleventh grade levels.

**Phase II: Development and Analysis of the Cognitive Tests**

**Pilot Testing**

An early decision was made to utilize a multiple choice format for the testing. This decision was based on recommendations from studies appearing in the literature at the time of ChemCom's development (Wall, 1972; Doran, 1980; Tuckman, 1975). The writing teams constructed rough drafts of 50 test items for each of the first two chapters or modules. Thirty-three were modeled after items appearing on the American Chemical Society's high school level standardized chemistry test and emphasized chemical content. Fifteen items emphasized applications of this content to societal issues. These draft items were reviewed and revised against the following six criteria:

- clarity of presentation
- content accuracy (validity)
- reasonable sampling of content from each chapter
- consistent format for all questions
- minimizing of redundancy and cueing
- maximum reading level of ninth grade.

Reliability was also a consideration; it is dealt with later. Each item was validated by a panel of specialists, three chemists and two educators, to assure (a) that they responded adequately to the ChemCom objectives and (b) their correct categorization as either chemical knowledge or application questions.

The assumption was made that a rigorous pilot student assessment following the teaching of the first two chapters would set an effective stage for the development of the remaining six end-of-unit tests and the final examination; all of which would be used in the field testing. The correctness of this assumption was borne out, as will be seen, by the results of the field testing.

---

**TABLE II**

Ranges of Median Responses, Average of Medians, Kendall Coefficients of Concordance (W) and Associated Probability Value (p) for Standards and Performance for Units I and II of ChemCom

<table>
<thead>
<tr>
<th></th>
<th>Chapter I</th>
<th></th>
<th>Chapter II</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Standards</td>
<td>Performance</td>
<td>Discrepancy</td>
<td>Standards</td>
</tr>
<tr>
<td>Range of Medians</td>
<td>3.0 - 5.0</td>
<td>3.0 - 4.7</td>
<td>0.3 - 0.7</td>
<td>3.4 - 5.0</td>
</tr>
<tr>
<td>Average of Medians*</td>
<td>4.5</td>
<td>4.4</td>
<td>0.5</td>
<td>4.2</td>
</tr>
<tr>
<td>W</td>
<td>0.62</td>
<td>0.64</td>
<td>0.25</td>
<td>0.47</td>
</tr>
<tr>
<td>X **</td>
<td>31.1</td>
<td>32.2</td>
<td>12.7</td>
<td>23.8</td>
</tr>
<tr>
<td>p ***</td>
<td>&lt;.001</td>
<td>&lt;.001</td>
<td>&gt;.2</td>
<td>&lt;.01</td>
</tr>
</tbody>
</table>

* Unweighted averages, giving each group equal leverage.
** Chi-squared values associated with "W".
*** Chance probability values for Chi-squared, indicating confidence to be placed upon the values for "W". For Standards and Performances, low "p" values indicate higher confidence. For discrepancies, the higher probabilities indicate that the calculated values are not below the accepted chance level of 0.05, and thus can be considered to be chance variations.
The tests to be piloted were administered to both an experimental and a comparison group. The experimental group had just completed a traditional chemistry course in an inner-city high school, while the comparison group had had no formal chemistry instruction. Each group was asked to comment on any difficulties they encountered in understanding any test item. Both groups indicated that the items were understandable and eighty per cent of the chemistry students indicated that they wished the chemistry course they had just completed had included information about how chemistry is applied to resolving environmental issues. The non-chemistry comparison group contributed almost no comments and, as expected, were not able to answer the questions above the chance level. Following minor revision of four items, these tests were then administered to over 1,000 students in the formal piloting process.

A shortened form of the Longeot Test for Cognitive Development Level was administered to the students who piloted Chapter II to determine if a relationship existed between the students’ level of cognitive development and their ability to answer correctly the pilot test items (Sheehan, 1970). Correlation of the Longeot and ChemCom scores revealed the involvement of the students in using the processes identified by Lawson and Wollman as requiring skills needed to apply knowledge to problem resolution (Lawson & Wollman, 1976). The results of this are described below.

Test and item analysis following the pilot testing of the two model tests included the following factors.

### Table III

<table>
<thead>
<tr>
<th>Unit I: Supplying Our Water Needs</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>COURSE TITLE</td>
<td>NUMBER</td>
</tr>
<tr>
<td>General Science</td>
<td>3</td>
</tr>
<tr>
<td>Physical Science</td>
<td>3</td>
</tr>
<tr>
<td>Chemistry</td>
<td>314</td>
</tr>
<tr>
<td>Other Sciences</td>
<td>49</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Unit II: Petroleum, To Build Or To Burn?</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>COURSE TITLE</td>
<td>NUMBER</td>
</tr>
<tr>
<td>General Science</td>
<td>0</td>
</tr>
<tr>
<td>Physical Science</td>
<td>16</td>
</tr>
<tr>
<td>Chemistry</td>
<td>332</td>
</tr>
<tr>
<td>Other Sciences</td>
<td>0</td>
</tr>
</tbody>
</table>

Inarticulate Science?

Perspectives on the Public Understanding of Science and Some Implications for Science Education

*by David Layton, Edgar Jenkins, Sally MacGill & Angela Davey*

The public understanding of science is a matter of concern in most countries. This is not simply because educators or scientists wish to promote a wider understanding of scientific ideas as worthy of the attention of all thinking citizens. Such understanding is commonly regarded as essential for the effective implementation of a wide range of social, economic, technological, medical, employment or other policies which have a scientific dimension. This book explores the ambiguities and limitations of the concept of ‘public understanding of science’ and, by means of case studies, addresses the meanings and social uses which science has for members of the adult public who are not themselves professional scientists. Drawing upon a substantial literature to place the case studies in a broader context, the final chapter examines the implications of the research for science education.

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25
Test Reliabilities

Reliability for each of the unit tests was 0.80 or better, indicating that revision on this basis was unnecessary.

Item Reliability and Discrimination

All but two of the test items were found to discriminate acceptably between the more academically able and the less able students. Revisions were made on two items having low reliability coefficients.

Cognitive Level

There was modest significant positive correlation, 0.40, between test scores and students' cognitive development levels, as indexed by the Shortened Longoet Test. This supported the contention that the tests contained a reasonable number of items functioning to assess understanding, application and other higher order thinking skills.

Time

Students' reactions during the piloting indicated that they required about 1.5 class periods to complete the items. For the field testing, each test was reduced in length from 50 to an average of 33 items to ensure that they could be reasonably completed in a 45 minute class period.

Level of difficulty

The index of difficulty for all but three of the pilot items fell within an acceptable range (0.3 to 0.8). Although these included the higher level items, the mean index of difficulty was calculated to be 0.45 for each test, indicating that, as planned, the overall tests fell close to 5 (Wood, 1966).

Relevance to the ChemCom Objectives

The five chemistry and science education specialists on the validation panel indicated unanimously that each test item was valid. That is, each item related to the students' attainment of the ChemCom objectives and that the total adequately reflected the content of each of the units.

Readability

Subjecting the items to the Dale-Chall Readability Formula indicated that the test items were, as planned, readable at the ninth + 0.5 grade level.

Applying Chemical Knowledge to Problem Solving

No significant differences in test scores between the experimental and control groups were found for those items designed to assess students' ability to apply chemical knowledge to the solution of societal problems. This unpredicted finding was interpreted to be the result of one or more of five possible causes. Of these possibilities, the evaluators and the ChemCom Steering Committee agreed that the most likely cause was that the time period (one to two months) was too short to have produced significant change in favor of the ChemCom students as expected.

The overall results of the pilot test evaluations indicated the correctness of the earlier assumption of no need to pilot each of the remaining seven tests. Thus the nine tests (eight chapter tests and the final examination) underwent only revision based on the experience of the pilot of the first two and final editing before their use in the field testing.

Field Testing

During the field testing, the cognitive tests were administered to nearly 2,700 students in seven centers across the United States: California, Washington, Maryland/DC, Colorado, Louisiana, New Jersey/New York City, Texas and Virginia. The 64 field test teachers taught each unit of ChemCom and administered each end-of-unit test and the final examination. A questionnaire, designed to reveal the characteristics of the teachers involved in the field testing was completed, and an ethnographic interview of a sampling of the field test teachers was done to confirm the questionnaire results and to determine their assessment of the future role for ChemCom and other courses with similar objectives.

The results of the field testing are reported in a detailed monograph on file in the Education Division Office of the American Chemical Society (ACS) in Washington, DC (Sutman, et al, 1989). This report and the originally published ChemCom Teachers Guide include the nine field-tested tests, with minor revisions to only five of the total 291 items, based on the field experience.

The field test students were then compared to two classes of students who had completed a conventional college preparatory chemistry course and with two classes that had no formal chemistry instruction. These

| TABLE IV |
| Total Test Reliabilities for each ChemCom End of Chapter Test and for the Final Examination |

<table>
<thead>
<tr>
<th>UNIT*</th>
<th>TITLE*</th>
<th>RELIABILITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Supplying Our Water Needs</td>
<td>0.53</td>
</tr>
<tr>
<td>II</td>
<td>Conserving Chemical Resources</td>
<td>0.80</td>
</tr>
<tr>
<td>III</td>
<td>Petroleum: To Build Or To Burn</td>
<td>0.60</td>
</tr>
<tr>
<td>IV</td>
<td>Understanding Foods</td>
<td>0.69</td>
</tr>
<tr>
<td>V</td>
<td>Nuclear Chemistry In Our World</td>
<td>0.67</td>
</tr>
<tr>
<td>VI</td>
<td>Chemicals, Air and Climate</td>
<td>0.71</td>
</tr>
<tr>
<td>VII</td>
<td>Chemistry and Health</td>
<td>0.69</td>
</tr>
<tr>
<td>VIII</td>
<td>The Chemical Industry: Promise and Challenge</td>
<td>0.79</td>
</tr>
<tr>
<td>Final Examination</td>
<td></td>
<td>0.82</td>
</tr>
</tbody>
</table>

* Order and titles as used during the field testing
### TABLE V
Analysis for the ChemCom Final Examination

<table>
<thead>
<tr>
<th>Groups Compared</th>
<th>t value*</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>ChemCom vs &quot;Naive&quot;</td>
<td>13.27</td>
<td>&lt; 0.001**</td>
</tr>
<tr>
<td>ChemCom vs &quot;Traditional&quot;</td>
<td>4.12</td>
<td>&lt; 0.01**</td>
</tr>
<tr>
<td>&quot;Traditional&quot; vs &quot;Naive&quot;</td>
<td>3.39</td>
<td>&lt; 0.01**</td>
</tr>
</tbody>
</table>

* All t values (one tailed) in favour of first named group

** Statistically significant at better than the customary confidence level of a 0.05 probability of a chance occurrence

---

Traditional and comparison groups were both from urban schools, the traditional group from a high school from which a high percentage of graduates enter college, many into programs emphasizing science, and the naive group from a school from which most students did not enter college. Beyond the data obtained by the evaluation team, the field testing provided valuable information to the editors of ChemCom for use in the final manuscript of ChemCom for commercial publication. This information, for example, helped to overcome some inconsistencies and problems related to the presentation of laboratory investigations found in earlier drafts.

**The Final Examination and the Effectiveness of ChemCom**

For the final examination, comparisons were made among the ChemCom field test group and the traditional and comparison groups noted earlier. The ChemCom field test group out-performed the other two groups in the area of applying chemical knowledge to societal problems.

In the area of chemistry content knowledge, final examination questions were written to be equivalent to a sample of items from the ACS examination, with the reading level adjusted to ninth grade (somewhat below that of the ACS test). The traditional group was predicted to out-perform the ChemCom group, and both the traditional and ChemCom groups to out-perform the comparison group. However, the ChemCom group significantly out-performed both the traditional and comparison groups! (See Table V). The results reported in this table clearly support the integrity of the ChemCom approach to instruction.

Part reliabilities for the two subtests of the ChemCom final examination were: for content, $R = 0.80$; and for Applications, $R + 0.58$. The reliability of the test as a whole was 0.76, a figure that meets accepted psychometric standards for such tests. Based upon the above data analysis, the conclusion is made that ChemCom is a highly functional high school chemistry course for secondary school level students for whom it is intended. Further, the program has the potential to be substituted for the more traditional high school chemistry course since it does not deter students from learning significant chemistry content.

**Phase III: Field Test Teachers and their Students**

The formal education of 67 per cent of the teachers included 30 or more academic credits in chemistry, and that 81 per cent of these teachers had taught more than six years, yet 42 percent of them had taught chemistry five years or less. Sixty two percent of the teachers indicated that their students were in a college preparatory program (not necessarily science-oriented), while 36 per cent of the students were enrolled in non-college oriented, while 36 per cent of the students were enrolled in non-college oriented, while 36 per cent of the students were enrolled in non-college bound curricula. Ninety percent of both groups of students were enrolled in the 11th and 12th grades. Not shown in the table is the distribution of teachers: nearly even between urban and non-urban schools, with a small percentage from rural schools.

**Phase IV: Teachers' Opinions Regarding ChemCom**

Most of the field test teachers perceived experience in the more traditional high
school chemistry course to be important for success as a science major in college. By contrast, the data from the field testing reveal that these teachers also believe that high school chemistry should meet the 'societal objective'. This dual role for high school was further analyzed in the ethnographic survey reported below.

This survey was administered to a carefully constructed sample of the field test teachers in order to provide in-depth information from the ChemCom teacher population that would be helpful in interpreting the results of the other aspects of the study. As an example, the ethnographic survey results reflected a perceived conflict between the need to prepare all high school level chemistry students to be successful in beginning college chemistry and an understanding of the role chemistry plays in the 'real world'. This possibly irresolvable contradiction occurs in the face of the results of historical science education studies that indicate that college chemistry faculty place relatively little value on the level and amount of formal chemistry taught in the high schools; instead only valuing adequate preparation in mathematics.

Summary
The results from the field evaluation of ChemCom indicate that while ChemCom was designed for a non science major-bound high school population it may also serve as appropriate background for science-oriented, college bound students! ChemCom experiences could, for example, motivate students to enrol in advanced high school chemistry courses and/or motivate them to enrol in college chemistry courses. The critical issue for college bound students continues to be where and how they will develop the necessary mathematics in the context of its use in the sciences. It would appear that serious rethinking of the school level approach to teaching mathematics, with perhaps a more utilitarian approach, as indicated in the National Council of Teachers of Mathematics' publication, Curriculum and Evaluation Standards for School Mathematics is in order.

The results of this research give some indication that ChemCom itself, or a ChemCom type high school chemistry program can better prepare students either to enter the work force directly from high school or to enter collegiate level science courses. While ChemCom may not be an effective curriculum 'for all Americans', the evidence is that the approach utilized by ChemCom better serves the needs of high school students than does the traditional approach to chemistry instruction. In light of this research, and in light of recent dissemination data, ChemCom has begun to play a significant role in molding the shape of high school chemistry in the years ahead.

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American Association for the Advancement of Science (1988) Science for All Americans: Summary of Project 2061

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28
The Bolivia Instructional Enrichment Partnership

by Jon E Pedersen

Introduction

Teaching science in a third world country such as Bolivia is difficult since many science teachers operate with little or no equipment and very few supplies. Few Bolivian schools have funds for staff development or professional enrichment. Hence, instruction in most Bolivian classrooms depends heavily on copying text material word-for-word along with rote memorization drills.

The lack of supplies, equipment and diversity of methods is a concern for many Bolivian educators. Because of this concern, a cooperative venture was initiated between the University of Arkansas at Fayetteville (U.S.A.), the Cochabamba Cooperative School, the Universidad Privado Boliviano, and the Minister of Education for Bolivia through its Servicio de Apoyo Educativo Departamental (S.A.E.D.). The cooperative venture, the Bolivian Enrichment Partnership, will provide Bolivian teachers with the opportunity to enrich their own classroom instruction with new ideas in teaching and learning.

The model used in the development and implementation of this project can provide guidance for other institutions as they develop international partnerships which promote the sharing of information and knowledge about pedagogical strategies and curricula.

The Planning

The planning team was comprised of a representative from the University of Arkansas, a Bolivian educator, a representative of S.A.E.D., the principal of the Cochabamba Cooperative School, and a representative of U.P.B. Not unlike any other planning team, this one wanted to ensure that their project would be successful both in the short and long term. For that reason, consideration was given to what it would take to make this project long term with appropriate short term impact rather than a workshop, that at best, is here today and gone tomorrow.

Based on the concern for long term impact, the focus of the planning team turned to an examination of the changes that teachers and others in the project would be experiencing from participating in this project.

In light of the above, a model of change was used as a guide for the development of the project. Although there are many effective models of change, most all of these models contain basic steps and considerations to use any time one attempts to restructure or reorganize. In the current project, the following basic change principles were used as guides in the development and implementation process. (Liberman & Miller, 1990; Timar, 1989; and Sizer, 1991).

- Agree on a new vision and from this develop the goals.
- Get conflict in the open.
- Understand that you cannot accomplish all your changes at one time. Change takes time.
- Go beyond surface issues in order to promote quality and equality for all students.

- Recognize the importance of building partnerships and networks with all involved and involve them early on.

In addition, there was also a need to consider cultural differences. This is especially true in light of the fact that individuals from the United States would be presenting, to Bolivian teachers, methods and curricula that they would use in their own classrooms with Bolivian students.

Vital to the understanding of the cultural differences was the input from Bolivian educators in regards to the impact that certain teaching methods and curricula might have on Bolivian teachers and their students. It was important to establish the "cultural correctness" of the methods and curricula that would be taught.

Through their involvement, Bolivian teachers and officials for S.A.E.D. were successful in shaping the proposed instructional strategies and materials to the culture of Bolivian teachers.

The Project

Change is never easy and as Cushman (1993) laments, "the first steps to change - agreeing that a problem exists, and setting goals to solve it - sound deceptively simple." (p. 4)

Knowing that all must have their say and raise concerns about the visions projected for the project, we spent a full year in discussions developing four main goals:

1. To improve the quality of teaching in Bolivian public and private schools which includes:

   A. To aid in the development of a philosophy of teaching that is consistent with current research on
science teaching and with the culture of the participants.

B. To broaden and deepen the understanding of Bolivian teachers knowledge of the current trends and research on science teaching.

C. To develop and implement appropriate teaching strategies for teaching science in Bolivia.

D. To develop curriculum which is consistent with the teachers' philosophy and compatible with current trends in science teaching.

2. To provide courses (during the winter break) for Bolivian teachers which will earn them credit towards their masters degree in education at the Universidad Privado Boliviano.

3. To prepare a cadre of Bolivian educators who can act as consultants in their own country.

4. To aid in the development of a masters degree program for education at the Universidad Privado Boliviano.

5. To develop long term and permanent opportunities for continued study and growth in education.

The new vision portrayed by these goals was one that was uniquely different from current trends in teacher education in Bolivia. In lieu of this extreme difference and understanding that change cannot occur rapidly, a four year plan was developed, as an organizational guideline, in order to implement the goals. Each year, a single change activity, which may address one or more of the project goals, would occur. In each successive year, the project would implement an additional change activity to address remaining goals. The important component of the plan was to go slowly, to be flexible and not demand that all of the project goals be completed in four years. We also developed consensus that if changes occurring were not positive, or if changes were being made too fast and were not meaningful, then the action plan could be altered.

The Action Plan

Year One: Establish an Instructional Enrichment Institute

The partners in the project will establish an annual summertime (northern hemisphere) Instructional Enrichment Institute to be held on the Cochabamba Cooperative School Campus. This will be comprised of a series of professional workshops on classroom instructional theory and methodology to be presented by faculty and/or associates of the University of Arkansas. Those teachers who go through this program will act as trainers in the process of facilitating current methods and theories of sound educational practices for other Bolivian teachers. It is important to note that the methods and theories presented will be based on current knowledge of teaching that reflect the reality of Bolivian culture and values.

Year Two: Establish a Post-Graduate Degree Program

A Master’s Degree program will be established at the new Bolivian Private University (Universidad Privado Boliviano, UPB) for the purpose of encouraging Bolivian teachers to seek and secure a post-graduate degree in the field of education. The establishment of the program will be a cooperative effort between the parties involved in the partnership. Courses for this Master’s Degree will be taught at UPB by UPB faculty. Cochabamba Cooperative School faculty (Americans trained in the United States), and faculty from the College of Education at the University of Arkansas.

Additionally, teachers who participate in the Instructional Enrichment Institutes will receive university credit toward their Master’s Degree at UPB.

Only Bolivian university graduates with degrees from a Normal and who possess Título Provisional National (Bolivian teaching certification) will be eligible for admission to the Masters program. Issuance of the Masters Degree in Education will be determined by the satisfactory completion of an approved course of study consisting of 30 graduate semester units of credit and satisfactory submission of a Project Thesis (describing the student’s approved educational research project).

Year Three: Establish the Universidad Privado Boliviano Shadow Program

Through its relationship with the College of Education at the University of Arkansas, UPB hopes to establish a closer relationship between other colleges at the University of Arkansas (including engineering and business) for the purpose of assisting UPB in the development of programs that would allow its students to apply and be considered for post graduate work at the University of Arkansas.

In addition, UPB will establish a “shadow program” at the University of Arkansas in order for the faculty at UPB to learn the latest methods in administration. This program would entail a faculty member from UPB being assigned to an administrator at the University of Arkansas for the purpose of becoming more conversant with current administrative management techniques.

Year Four: Establish the Continuing Education Center (C.E.C.)

Cochabamba Cooperative School in Bolivia will provide land for the construction of a resource facility providing research, training, and development opportunities for Bolivian teachers who are members of the Institute, Cochabamba Cooperative School faculty, faculty from the College of Education at the University of Arkansas, and student teachers from the College of Education at the University of Arkansas.

The Continuing Education Center will be a complete instructional resource facility. It will offer the facilities and resources necessary to provide technical and professional assistance to Institute members for improving the quality of instruction in their individual classrooms.

The Center will provide a resource facility for teachers in Bolivia to visit and from which to learn. This is a dire necessity as teachers in the Bolivian public school system lack the monetary resources to pursue their own professional growth. The Continuing Education Center would provide them with the opportunity to (1) study and/or pursue research at the professional/classroom library; (2) to observe proven instructional techniques in the demonstration classrooms or auditorium on educational trends and instructional methodology; (3) to create their own teaching models and instructional materials in the resource workroom; and (4) to learn from the most advanced technologically equipped educational computer facility.
in Bolivia.

The Center will also provide housing for out-of-area staff, visiting educators, and student teachers from the College of Education at the University of Arkansas. It will provide daily pick-up and return transportation for teachers who live outside the Cochabamba transportation system.

Conclusions

The project has completed its first year, and is leading into the second summer institute. Over 40 Bolivian teachers participated in the initial two week institute which covered basic science methods. After the two week workshop, 35 of the 40 teachers agreed to continue to meet every Friday evening to further discuss science methods and share their own experiences using the new methods of instruction. This was all initiated, coordinated and carried out by the participating teachers.

The Bolivian teachers have all indicated that the first year experience has been positive. The increased knowledge of methods has provided for them an increased flexibility and diversity vis-a-vis science teaching. The teachers have also indicated a desire to continue their professional development through additional workshops and institutes which focus on curriculum development to further enhance their effectiveness as science teachers.

The second summer institute will occur June of 1993. Rough estimates are that 100 Bolivian teachers will participate in an introductory methods workshop and an advanced workshop (the advanced workshop will be for those who participated in the first summer institute). The goal of the advanced workshop is three fold:

1. to provide teachers with a broader and deeper understanding of science methods through experiences
2. to provide the teachers with an understanding of curriculum development by application, and
3. to provide the teachers with an understanding of the change process so that they can begin to formulate a plan of action to train other Bolivian teachers.

In addition, work has begun on establishing the first masters degree program in Bolivia for teacher education.

The success or failure of a project such as this rests with the individuals who have a stake in the effects of the change. Many of us have good ideas and good intentions of sharing our ideas with others. Yet, we must ask ourselves if our vision is shared by all of those individuals that it will impact.

Can we be sure that those who are most effected by change see a need to change? Or, do they have the attitude, if we don't think it is broke, don't fix it? Without the commitment of all involved in the project, the vision of one becomes little more than an imposition on others.

References

Cushman, K (1993) "So now what?" Managing the change process Horace 9(3), 1-11


About the author

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Photo (above): Prof John Penick (USA, right) and Mr J N Matteo (India, left) share a moment with Commandant Jacques Cousteau (France, centre) following the opening plenary session of the International Forum, Paris, July 93.

Photo (below): Brendan Honeyman (ICASE President, left), Dr Jack Holbrook (ICASE Executive Secretary, centre) and Dr Leo Rebello (India, right)
Subtitle: Anthropomorphizing: Another Teacher’s Methodology for Better Pupil’s Learning in Science

According to Solomon (1986) anthropomorphizing is helpful in teaching children and is used frequently in different ways in our culture. It is a kind of analogical reasoning. Consequently it is a precious tool for expanding human knowledge (Dupin & Joshua 1989, Duit 1991).

The teacher introduces the idea of water molecules as human beings in motion (Figures 1 and 2). This metaphor is based on developing animate attributes of water molecules and ideas on their kinetic behaviour. These ideas permeate discussions on the explanations of their observations. A method which runs through all teachers’ remarks to children (9-10 years old) is that we are ‘explaining a physical phenomenon, such as the water molecules’ motion, on the basis of human being moving behaviour.’ The learner builds a set of useful water molecule activities out of some already existing set from his/her experience on human activities. According to Fisher (1987) this learning state is called the personal analogy where pupils place themselves directly in the same situation with water molecules, as it happens in the above mentioned event.

As mentioned below, water evaporation is something mysterious; no acting mechanisms can be seen, only effects. So, children reason by means of anthropomorphized water molecules on the basis of their daily life experience. Under this approach, the teacher sets the new idea of water evaporation in a concrete form. It is essentially a picture. The teacher’s purpose is not to perform new empirical experiments, but to encourage ‘thought experiments’. Pupils must think about the new system (evaporation of water = water’s disappearance and/or quicker water’s disappearance), go deeply into it and propose some relevant hypothesis. By confrontation with other pupils and with the teacher, it is possible to reach a reasonable physical model.

Water molecules in motion!

Water is not only a material that you can drink or swim in or wash yourself with. Studying its properties can be an engaging hobby because you can find out the answers to some of water’s ‘why?’ and other interesting things that you can do with water.

Can you present that water molecules move?

STEP ACTIVITY 1: WATER’S DISAPPEARANCE

Challenge

How can you explain water’s disappearance?

What you need

A water glass, a bottle, a measuring cup and water.

Do

Drop the same quantity of water in (a) a water glass, (b) a plate, and (c) a bottle. Put them in a certain place where they receive the same quantity of sun radiation and heat (Figure 1).

Further investigations (expected outcomes)

(a) What happens to the water in each case? In all three cases the water ‘disappears’ or evaporates.

(b) Is there any difference? The quickest ‘disappearance’ (evaporation) is of the water in the plate. The water in the glass evaporates more quickly than the water in the bottle.

(c) What ideas have pupils to explain the difference?

Teacher’s notes

A great number of water molecules (eg in a lake, a river or the sea) escape into the atmosphere. In this case water ‘disappears’ or evaporates (the more accurate physics term). The teacher can introduce a model of water molecules as in Figure 1, for a better pupils’ understanding of the phenomenon of evaporation. That is, pupils understand that the water in the plate evaporates most quickly, because the largest free surface permits water molecules to move into the air without any obstacle. What seems to be the case with the bottle is that the smaller opening makes it more difficult for molecules to escape into the atmosphere.

Pupils’ interpretation

Most pupils hypothesize that in all three cases the same quantity of water disappears because the conditions are the same. They set fair tests by taking measurements of the heights of or depths below the level of the water surface in all cases after a predetermined period of time (eg 3-5 minutes) in order to verify their hypothesis. Pupils write down their measurements and observations as to in which case water disappears the fastest. They ask questions such as ‘why?’ or ‘how can we explain this water’s behaviour?’ and other similar ones. They express various ideas on it. The teacher’s proposed model sharpens their ability to explain this kind of water behaviour because anthropomorphizing water molecules helps pupils to draw a parallel between human behaviour and the behaviour of water molecules, as a result to understand the latter by analogy to their personal experience.
Figure 1 (left)

Place a measuring cup of water into each container.

An imaginary picture of evaporating water molecules.

Figure 2 (right)

Faster water disappearance due to heat.
STEP ACTIVITY 2: QUICKER WATER DISAPPEARANCE

Challenge
Can you explain why water molecules disappear more quickly by heating?

What you need
Three saucepans of the same size, a measuring cup and water.

Do
Using the measuring cup, pour the same quantity of water into each saucepan. Put the first saucepan in a cool place, the second one in a warm place (e.g., in sunshine or near a heater) and the third one on a cooking plate (e.g., an element of an electric cooker) and leave it boiling (Figure 2).

Further investigations (expected outcomes)
(a) What happens with the saucepan in the cool place? Water evaporates (at a slow rate) even in a cool place.
(b) What happens with the saucepan in a warm place? Water evaporates at a faster rate than in the previous case.
(c) What happens with the saucepan on the cooking ring of an electric cooker? Water evaporates at the fastest rate.
(d) How do pupils explain these differences? They claim that heat facilitates the water's evaporation.
(e) What ideas do pupils have about water evaporation? The water molecules' anthropomorphized model helps pupils to understand that the higher the temperature, the faster water evaporates.

Teachers' notes
Scientists claim that water molecules move faster and distances between them become greater when they are heated because of the energy which is transferred to them by heating. Thus, they 'escape' more easily from the water surface into the air, changing from liquid to vapour.

Pupils' interpretation
Most pupils hypothesize that the water in the saucepan on the cooking plate evaporates more quickly based on their experience gained from daily life. Many pupils form the opinion that sunshine or a heater also assists water to evaporate more quickly — and that this does not appear to happen in a

References


About the author
Dr Kavogui has been studying at Kings College, London for a research degree in science education. During her time in England, she taught primary science which heightened her interest in and awareness of interpreting science in children's terms. She developed this teaching strategy in response to pupils' apparent needs with success in terms of the pupils' participation in problem solving science activities.

ICASE Stepping into Science
Come and Share
ASE Annual Meeting
January 1993

Photo: Participants enjoying one of the many activities shared at the popular ICASE Come and Share session at the ASE Annual Meeting, January 1993
Stepping into Science
An ICASE Primary/Elementary Science Project

AIMS
Stepping into Science is an ICASE project which aims to:

• Establish an international network for teachers to share ideas on the teaching of primary/elementary science and technology.
• Provide activities and support for teachers, thereby encouraging them to include more science in the primary/elementary curriculum.
• Promote the value of science experiences for young children throughout the world.
• Facilitate professional development opportunities for teachers by including sessions on primary science and technology in regional and international conferences.

ACTIVITIES
The Stepping into Science Team is actively involved in a number of projects and activities including:

• Publishing STEPS, the Stepping into Science Project Newsletter. This newsletter contains ideas for class activities at various levels in primary/elementary schools, activities for children to do at home, comments by network members on issues, examples of children's work, lists of helpful resources and contacts.
• Contributing articles and ideas for the Primary Science Section in Science Education International, the ICASE quarterly journal.
• Compiling ideas and activities for inclusion in a series of sourcebooks on the teaching of primary/elementary science and technology.
• Coordinating a scheme to encourage children to participate in science and technology activities. Certificates of Participation have been produced, and are available for schools to use in rewarding students as they complete a number of activities. Certificates are colour coded in seven different colours, so that they can be used to acknowledge progress in science from early to advanced levels within primary/elementary schools. ICASE is grateful to BP (Oman) for sponsoring this scheme.
• Organising Stepping into Science workshops and displays of children's work at national, regional and international conferences.

FOR MORE INFORMATION
Contact the ICASE Primary Science Officer:
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ICASE Primary Science Officer
Stepping into Science Project
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United Kingdom
The Scientific Work Experience Program
A new and important model for science teacher development

by Sandra S Gottfried

Scientific work experience programs are those in which teachers work within businesses, industries, or universities in a variety of roles. By engaging in the scientific enterprise, teachers gain an understanding of the nature of the scientific process and infuse these understandings into their professional lives. In addition, involvement in scientific work experience programs increase teachers' feelings of self-confidence, self-esteem, and professionalism.

More than 80 scientific work experience programs are now in existence in the United States (Industry Initiatives for Science and Math Education, IISME, 1991). A few programs began in the late 1970s, but most were developed from the mid-1980s to the present. Although differences exist among scientific work experience programs, they have many commonalities.

Most programs take place over six to ten week periods in the summer with follow-up during the school year. Some programs have continuing work experiences spanning the school year and have academic experiences (such as courses or workshops) that extend beyond the summer. Many programs offer university credit for participation; some are a part of a master's degree program. All are considered internships because teachers work with mentors from the setting in which they are placed to do supervised work.

The goals of most scientific work experience programs include giving teachers 'real world' experience in business, industry, or academia. Project directors are interested in teachers improving their technical/scientific knowledge base. In addition, project directors and developers want teachers to use the internship experience to enhance their understanding of some of the kinds of skills scientists, engineers, and other types of technical workers need in the workplace. A related goal is for teachers to see the usefulness of scientific, mathematical, and technological knowledge and skills in a variety of 'non scientific' careers and occupations. These new understandings and insights enhance a teacher's ability to teach science and help students make academic and career decisions. Many programs also suggest additional goals of enhancing teachers' leadership skills, awareness and understanding of current science and technology, understanding of developing technologies, and understanding of the nature of scientific research.

Scientific work experience programs can be grouped into three categories according to the type of scientific work teachers do: project internships, research internships, and a combination of both research and project internships.

In project internships, teachers are placed within business or industry and complete a project for the company. Often these are projects that the business could not get to with its available workforce. For example, a teacher may be asked to set up and test new equipment, write manuals, teach within the company, or modify computer programs.

In research internships, teachers are placed in business, industry, or university settings and work with research scientists or engineers. Each teacher takes part in some aspect of the research work of his or her mentor. The research questions teachers explore vary tremendously and span both domains of basic and applied research. In project/research internships, some teachers are placed in business, industry, or university research settings, while others are placed in business or industry with a project focus.

The predominant method of classroom transfer in both research internships and research/project internships is a curriculum development project. Through the development of their projects (a process often facilitated by a science educator) the teachers translate their summer experiences into instructional materials. In research or research/project internships not using this mechanism, teachers are often asked to submit a personal action plan of classroom transfer. This plan allows teachers a wide latitude to develop classroom and extracurricular activities they will carry out during the school year and encompasses topics such as teamwork, problem solving, communication skills, updating of content, and career awareness. Some programs have no structured mechanism of classroom transfer.

An overwhelmingly consistent outcome reported by directors of all three types of scientific work experience programs is the increase in teachers' feelings of self-confidence, self-esteem, and professionalism. Scientific work experience programs are often catalysts, energizing teachers to aggressively pursue further professional development activities. These programs 'recharge' teachers. After their summer experiences, most teachers are anxious to return to their roles in their classrooms, having reaffirmed their reasons for entering the teaching profession. On sharing their experiences and new workplace perspectives with students, teachers sense that students view them as credible professionals in ways they
previously had not. Teachers describe their students as being genuinely interested in their experiences and eager to learn about happenings at the various corporations, universities, and research institutions.

Another consistent outcome reported by directors is the realisation on the part of teachers that communication skills as well as skills of cooperation and problem solving are essential in the scientific/technological workplace. Teachers report that this realisation occurs as they are put in learning-intensive roles that bring them into contact with new people, new viewpoints, and new ways of looking at problems. As learners, teachers have a unique opportunity to reflect on the learning process as they engage in experiences that challenge them to rethink their own thinking and their own abilities to solve problems as individuals and as members of teams. Following participation in scientific work experience programs, many teachers report that they now plan lessons to develop these skills in their students and work toward increasing the use of cooperative learning strategies in their classrooms.

The shift in teacher attitudes relative to teaching/learning, the workplace, and professionalism has great potential for altering teachers' decisions regarding curriculum practice, district policy, and professional standards. Most teachers believe that direct, personal interactions with colleagues are the most effective ways to serve as change agents in their schools and school districts. Much of this interaction occurs in day-to-day conversations. Broader means of interaction and influence occur through curriculum committees, strategic planning committees, staff development programs, and program assessment committees.

Many teachers reflect on the internship experience as having long-range effects on their careers as teachers. Post-internship discussions and follow-ups with many teachers reveal other aspects of professional development that are directly or indirectly associated with their involvement in the program. Some of these aspects include:

(a) attending more professional conferences,
(b) attending or providing after-school workshops,
(c) taking additional coursework,
(d) seeking other internships,
(e) volunteering as mentors in school programs, and
(f) establishing links with industry and research personnel.

Each teacher's additional professional development experiences ultimately feed back into the classroom, school, and school district to enhance and enrich science, technology, and mathematics education.

Author's note: A more complete discussion of research-related internships appears in:

Gottfried S S, Brown C W, Markovits P S, and Changar J B (February 1993) Scientific work experience programs for science teachers: A focus on research-related internships. Association for the Education of Teachers in Science (AETS) Yearbook

References


Unpublished list of program profiles, University of California, Berkeley, Lawrence Hall of Science, Berkeley

About the author

Sandra S Gottfried is based at the University of Missouri – St Louis, USA.

ICASE Stepping into Science Workshop
NSTA Convention, Kansas City

Photo (above): Sue Dale Tunnicliffe (left) ICASE Primary Science Officer, with Dr Lisa Nyberg (right) of CESI together at the first ICASE Stepping into Science Workshop, organised for the National Science Teachers Association (NSTA) Convention in Kansas City. Dr Nyberg presented some native American Indian activities on papermaking and colouring which can be used in elementary programs. The session was chaired by the (then) ICASE President, Mr Bob Lepischak. Photo by courtesy of Rosamund Hilton, Chicago.
Policy, Practice and Professional Judgement: School-Based Assessment of Practical Science
by J F Donnelly, A S Buchan, E W Jenkins and A G Welford

Practical work has had an important place in British science education for many decades. However, it was only in 1988, with the advent of the GCSE, that assessment of pupils' practical abilities was required within all science examinations occurring at the end of compulsory schooling. The innovation was welcomed by many science teachers, but it was also seen as the most problematic part of the new examination in science. The study reported in this book involved an in-depth examination of the implementation of this policy. It took place between 1990 and 1992, and involved extensive interview with schools together with a national questionnaire. The findings raise important issues, both about how policy decisions in education are taken and implemented. Those issues are of increasing significance as science education practice becomes even more subject to centralised control in the context of the National Curriculum.


Teaching Science for Social Responsibility
by R T Cross and R F Price

This book explores the nature and place of science, using that word very generally, in the wider society. The authors try and show that the common assumption among science teachers, that the science they teach is a simple but faithfully reproduced model of science in the wider, R&D world, is, in important ways, not correct. The authors also set out to make clear why this is and what can be done about it. The authors believe that science teachers, like all teachers, and indeed all members of a democratic society, share a common responsibility for the future of humanity. The special responsibility of science teachers is to teach in a way that reveals the socially produced nature of scientific theory and to teach the scientific knowledge and skills required for an understanding of the social issues which the public is increasingly being faced with. This, the authors contend, requires a different attitude to science from that which has been traditionally held by classroom teachers. This book extends the discussion initiated in the STS movement and illustrates that, by concentrating on the examination of the scientific evidence required for evaluating social issues involving science and technology, science teachers will be fulfilling their special responsibility.

ICASE is keen to arrange regional or world events for the benefit of member associations. If your association or organisation is interested in hosting an international seminar, workshop or conference, contact the Executive Secretary or your Regional Representative. To gain ICASE endorsement, the meeting must be international in nature, open to member associations, and, while all sectors of the science education community should be encouraged to participate, must be relevant to classroom teachers.

1993

September 6-16
Science, technology and society – appropriate science education for the twenty first century
Location: Department of Educational Studies, University of Oxford, UK
Contact: Courses Department, The British Council, 10 Spring Gardens, London SW1A 2BN, UK
Participants focus on the following issues: (1) the nature of STS as education; (2) objectives and the evaluation of courses; (3) information, knowledge and public understanding of science; (4) industry and STS; (5) STS in developing countries; (6) law, values and decisions about the environment; (7) new curriculum materials; and (8) teachers and in-service education. The seminar is intended for experienced science teachers, educationists, and government officials involved with curriculum planning and implementation and in-service work with teachers.

September 11-14
2nd European Conference on Research in Chemical Education
Location: Pisa, Italy
Contact: Dipartimento di Chimica e Chimica Industriale dell'Università di Pisa, Risorgimento, 35, 56126 Pisa, Italy
This conference aims to describe the state of chemical education research and to help chemists develop this research, and develop a European cooperation for the defence and promotion of didactics. Topics include presentations and discourses, evaluation, trends in didactics, problem solving, experimental teaching, computer assisted teaching, new technologies, and chemistry and the environment. Languages of the conference will be English and Italian.

November 22-27
Asian Workshop on Global Change Education
Location: Madras, India
Contact: Prof R R Daniel, Scientific Secretary, Committee on Science and Technology in Developing Countries (COSTED), 24 Gandhi Mandap Road, Madras 600 025, India
COSTED, because of its interest in the promotion of environmental education in developing countries, is considering an evaluation of the suitability of the materials on Global Change produced by ICSE-CETS to meet the needs of teachers and students of the developing world. Participation is by invitation only.

1994

January
ASE Annual Meeting
Location: UK
Contact: Annual Meeting Secretary, ASE Headquarters, College Lane, Hatfield AL10 9AA, UK
Full details of this large international event will be circulated in Education in Science, a journal of the Association for Science Education.

April 7-23
Sixth Edinburgh International Science Festival
Location: Edinburgh, Scotland
Contact: Marion-Jane Patie, Assistant Chief Executive, Edinburgh Science Festival Ltd, 1 Broughton Market, Edinburgh EH3 6NU, Scotland, UK
Following the success of the 1993 Festival which attracted over 200,000 people to 367 events, preparations for the 1994 Festival are now well in hand. Major themes include: (1) Being the right size; (2) Molecule of the day; (3) Science myths of our time. In addition, exhibitions, talks, debates, workshops (including Madlab, Computer Arcade, Funamental Physics, Science Dome), family events, performances, tours, and conferences will be featured in the program.

July 4-8
CONASTA 43
Location: Launceston, Tasmania, Australia
Contact: Donna McWilliam, CONASTA 43, PO Box 1922, Launceston Tas 7250, Australia, Fax (003) 34 2598
The theme for the 43rd annual conference of the Australian Science Teachers Association (CONASTA 43) is 'In from the cold'. The program brings contemporary developments and information to teachers within an atmosphere of support. Hear about new ideas and approaches in science and technology, keep abreast of latest developments, evaluate new resources, and meet teachers from all over Australia and beyond. Keynote addresses, workshops, displays, social events and a family program make Launceston an exciting place to be in July '94!

July 27 - August 10
London International Youth Science Forum
Location: London, UK
Contact: LIYSF, PO Box 159, London SW10 9QX, UK
The Science Forum is the principal annual meeting in Britain of young scientists. Over three hundred students attend from some fifty nations to make this an international event of major significance. The program features lectures, seminars and demonstrations from leading scientific names, and an extensive range of visits to university and industrial research establishments.

August 8-12
13th International Conference on Chemical Education
Location: San Juan, Puerto Rico
Contact: Kam S Lumba, Chairman 13th ICCE, Inter American University of Puerto Rico, PO Box 191293, San Juan PR 00919-1293
This will be the first time that an ICCE meeting will have been held in the Caribbean Region. The objective of this conference is to bring together chemistry teachers from the pre-college and college levels to share ideas and learn from each other about innovations in the teaching and learning of chemistry. The theme is 'Chemistry: The Key to the Future'. The Conference will feature plenary lectures, symposia, lecture presentations, workshops, poster sessions and exhibitions. Scientists and science educators from around the world will report their work.

August 24-31
7th International Symposium on World Trends in Science and Technology Education
Location: De Koningshof, Veldhoven, The Netherlands
Contact: Secretariat 7th IOSTE symposium, PO Box 2041, 7500 CA Enschede, The Netherlands
Symposium presentations will be organised around at least three cross-curricular areas of interest: (1) science/technology related social issues including environment, health, peace, third world development, risk and safety; (2) further education and employment including career orientation, career preparation; (3) teaching methods include fieldwork, cross-curricular projects, computer simulations. Proposals for these and other topics are invited that report/reflect on research, practical experience or innovations relating to the main theme of 'Science and Technology Education in a Demanding Society'.

September 21-22
Third Symposium on Education Industry Partnerships
Location: Frankfurt, Germany
Contact: Drs Jan Hendriks, Koninpad 3, 7921 BM Zuidwalde (DR), The Netherlands
The 3rd Symposium on Education Industry Partnerships will be hosted by the Association for German Chemical Industry (VDI), and organised by Hoechst. The program will be a most relevant follow-up to the recent Project 2000+ International Forum, since Education-Industry Partnerships are an important strategy for improving scientific literacy.

December 6-10
9th ICASE Asian Symposium
Location: Bangkok, Thailand
Contact: Dr Janchai Yingprayoon, Science Society of Thailand, Physics Bldg, Faculty of Science, Chulalongkorn University, Bangkok 10330, Thailand, Fax +662 253 1150
ICASE Asian Symposia are always a significant event in the Asian region, attracting delegates across the region and further afield. Science Education International will announce details of the next symposium to be held in Bangkok in December 1994.

1995

June 5-12
XVIII Pacific Science Congress
Location: International Convention Center, Beijing, China
Contact: Secretariat, c/o Institute of Atmospheric Physics, Chinese Academy of Sciences, PO Box 2718, Beijing 100080, PR China, Fax +86-1-2562458
The Pacific Science Association invites delegates to this Pacific Science Congress which focuses on the theme 'Population, Resources and Environment: Prospects and Initiatives. Scientific sections include Science Communication and Education. For those who are interested in receiving a First Circular, write to the contact address above.

July 26 - August 9
London International Youth Science Forum
Location: London, UK
Contact: LIYSF, PO Box 159, London SW10 9QX, UK
The Science Forum is the principal annual meeting in Britain of young scientists. Over three hundred students attend from some fifty nations to make this an international event of major significance. The program features lectures, seminars and demonstrations from leading scientific names, and an extensive range of visits to university and industrial research establishments.

August 25 - September 1
International Conference on Industry-Education Initiatives in Chemistry
Location: University of York, UK
Contact: Miranda Mapleton, Chemical Industry Education Centre, Department of Chemistry, University of York, York YO1 5DD, UK, Fax +44-904-432516
This international conference is co-sponsored by the International Union of Pure and Applied Chemistry (IUPAC) Committee on Teaching of Chemistry, and the Royal Society of Chemistry Education Division and Industrial Division.

September
CONASTA 44
Location: Brisbane, Australia
Contact: David Tulip, Convenor, CONASTA 44, Queensland University of Technology, Locked Bag No 2, Red Hill QLD 4059, Australia
The theme of the 44th annual conference of the Australian Science Teachers Association (CONASTA 44) will be 'The Science Teacher – An International Perspective'.
Extending and improving education in science for all children and youth by assisting member associations throughout the world

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Science Education International is the Quarterly Journal of the International Council of Associations for Science Education. ICASE was established in 1973 to extend and improve education in science for all children and youth by assisting member associations throughout the world.

This journal provides a means for associations, institutions, centres, foundations, companies and individuals concerned with science education, to share perspectives, concerns, ideas and information which will foster cooperative efforts to improve science education, and which will serve as a chronicle of the advancement of science education throughout the world.

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Dates for Receipt of Contributions

<table>
<thead>
<tr>
<th>Issue</th>
<th>Closing Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>March</td>
<td>1 February</td>
</tr>
<tr>
<td>June</td>
<td>1 May</td>
</tr>
<tr>
<td>September</td>
<td>1 August</td>
</tr>
<tr>
<td>December</td>
<td>1 November</td>
</tr>
</tbody>
</table>

ICASE News

Feature Articles
A race between school and cradle Jacques-Yves Cousteau
Scientific and technological literacy for all: A perspective reality Thomas R Odhiambo
Science education in developing countries: What’s the point? C J Stoll

Science Education Around the World

Research on Teaching and Learning
Science, technology and communication: Utilisation depends on access Mitch O'Toole

Science Teacher Education
Professional development for science teachers: a school based approach John Loughran

Primary Science
Exciter Paks: A classroom resource playing a role in professional development B N Honeyman

Science Technology Society
1993 International Model Solar Car Challenge

Resources

Calendar

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Science Education International

A new editorial team for 1994

By Brenton Honeyman
President, ICASE

As you read this, a new editorial team will have commenced the task of producing the March 1994 issue of Science Education International. Ronald J Bonnstetter of the Center for Curriculum and Instruction at the University of Nebraska, USA will head the new team, comprising key science educators around the world. And just as the founding editorial team established new ground for ICASE four years ago, I am looking forward to seeing the ICASE Journal grow in its impact as it takes on new challenges and some revisions in format. I wish Ron and his team well as they undertake this important task on behalf of ICASE.

Just over four years ago, the ICASE Executive Committee endorsed the proposal that an ICASE Journal be published as a quarterly service to member associations, replacing the newsletter which had been produced until that time. This venture set out to provide a means for member associations, institutions, centres, foundations and companies, and for individuals concerned with science education, to share perspectives, concerns, ideas and information which would foster cooperative efforts to improve science education, and which would serve as a chronicle of the advancement of science education throughout the world.

Through the early establishment of editorial policy which sought to include a wide selection of articles representing input from as many different regions of the world as possible, the ICASE Journal has provided readers with a series of 'snapshots' of what is happening in science education around the world. For me, this has been a particularly rewarding aspect of my involvement with Science Education International.

For the past four years have put our team in a very privileged position to receive inputs from every corner of the globe. The diversity and, at the same time, the inter-relationship of ideas and issues around the world have meant that our task as an editorial team has been an enlightening experience. Thank you to all the many contributors for making our job an interesting one, and for being willing to share your insights and your experiences with the readers of Science Education International.

It is now four years since the journal content and format policy was developed. It is time, therefore, that we review the journal and prepare for changes which will strengthen both the content appeal to member associations and journal subscribers, and also the marketability of the journal leading to increased subscriptions.

There are many challenges ahead for the ICASE Journal. Jack Holbrook's recent participation in an International Meeting on Science Education Journals provided plenty of ideas for development. For some time now, we have been challenged by the task of providing journal articles in languages other than English. Resources permitting, this is an important development for ICASE to accomplish in the near future.

With the momentum of Project 2000 and its focus on six key areas of concern, there has been some initial discussion with the new editorial team in aligning the journal's columns with those six key areas.

I wish to record my thanks and appreciation to the many people who have supported the journal in various ways. In particular, my thanks go to the section editors and members of the advisory board — to Ron Bonnstetter, Lucille Gregorio, Jack Holbrook, John Penick, Mari Silis and Sue Dale Tunnicliffe. Their resolve to establish regular columns which share important ideas and statements in international science education has played a key part. My thanks also go to Jack Holbrook for his tireless technical support in supervising the journal printing and distribution. I am most appreciative of Dennis Chisman's diligence in managing subscription renewals. In addition Jack Holbrook, John Penick, Dennis Chisman, Bob Lepischak, Jan Hendriks, Ken Roy and others have worked hard to ensure that there is a constant flow of input to and articles for the journal — this has been critical in ensuring a balance of input across the globe, and I am very grateful for their efforts.

Through my previous role as Convener of the ICASE World Conference on Science Education and the Quality of Life which was held in Canberra, Australia in July 1988 and my roles as editor of Science Education International and Who's Who in Science Education Around the World, I have been in a key position to develop an extensive worldwide network of science educators. For this, I am very grateful, and I look forward to continuing the work of ICASE with friends and colleagues around the world in my new position as President.

Brenton Honeyman (Photo: left)
ICASE President
New Regional Representative for Latin American and Caribbean Region

ICASE welcomes Dr Jose A Chamizo to the ICASE Executive Committee, as the new Regional Representative for the Latin American-Caribbean Region. As the regional representative, he will be liaising with ICASE member associations and institutions in the area, and endeavouring to build up a strong network of science teacher associations in this important region. Dr Chamizo can be contacted at Colegio Madrid, A.C., Calle Puente 224, 14380 Mexico D.F., Mexico, Tel +52-5-673-1959, Fax +52-5-673-1826 for science education in the global community, working with its members to enhance the quality of science education for all.

• Strengthening the financial base of ICASE so that the Council is able to carry out its programs;
• Expanding existing services, and developing new services to meet the evolving needs of member associations, institutions, centres, foundations, companies and individuals with an interest in science education;
• Identifying and involving science educators and others in assisting the Council to carry out its initiatives.
• Developing policies and operational procedures to facilitate existing programs, and to more effectively address and respond to new challenges.

A new information folder entitled ICASE: The People and the Organisation is being compiled for use in increasing ICASE membership (currently 120 member associations, institutions, foundations and companies around the world), and in negotiating the involvement of organisations and companies in the support of ICASE programs.

For more information, contact Maris Silis, Policy & Development Officer.

ICASE Five Year Development Plan

The Executive Committee is currently considering a draft of the new five year development plan, which will be used to guide ICASE in terms of key areas of operation. Five major areas for development include:

• Establishing ICASE as an advocate

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A Race Between School and Cradle

By Captain Jacques-Yves Cousteau
A Project 2000+ International Forum Address

This article is the text of a plenary address presented at the International Forum on Scientific and Technological Literacy for All held at UNESCO Headquarters in Paris on July 8, 1993.

When 106 heads of state and more than 135 national delegations closed the all-important Rio Conference on Environment and Development, simultaneously more than 800 Non-Governmental Organisations, originating from all over the world, closed their picturesque and vibrant meetings by a concert of hope and revolt. What had motivated such a momentous gathering? Certainly not just the desire to celebrate the twentieth anniversary of the historic Conference of Stockholm, but rather a growing, roaring consciousness that the future of our planet could be threatened and that the very survival of our species could be at stake. In spite of shocking differences between what was called the South and the North or between the East and the West, the people at large were realising that a global consciousness was born, and that neither the leaders nor the media were reacting accordingly to this universal need for closer solidarity.

What concrete results were adopted in Rio? A revolutionary program of badly needed reforms? Of course not! The two timid conventions signed, about biodiversity and global warming, as well as an inflated document, Agenda 21, were immediately criticised by a sarcastic press still under the influence of industrial lobbies. We must open our eyes, our ears, our hearts! The songs and dances at the Rio Forum, were irreversible hymns of hope and of faith in humankind, and the incomplete, laborious decisions of the 'Earth Summit' had made 'business as usual' impossible forever.

What is the future of the Rio spirit? A solution to the so-called economic crisis that affects only one fifth of humankind? Or to the unemployment tragedy that plagues a growing fraction of the wealthy nations? No, but now the whole world understands that in the third world unemployed are not counted in millions, but in billions, that the economic crisis is there – in Africa, South America and Asia – not as an artifact, but as an endemic plague.

And thanks to Rio, nobody on earth will tolerate any more that the rich would carry on getting richer, and the poor would become even poorer. This simple message was never as clearly heralded as in Rio and now, the leaders of countries as well as the international forces – UN, UNESCO, World Bank, IMF, EBRD, UNDP, WHO and UNEP – will be orchestrated by the UN Commission for Sustainable Development to implement the Rio Conventions and Agenda 21.

Photo (above): Captain Jacques-Yves Cousteau. Courtesy of Equipe Cousteau, Paris, France

It is true that, in Rio, the paramount problem of population explosion was not identified as the major obstacle to our future. And the words 'sustainable development' were often branded as symbols of an upcoming miracle. The permissive use of that expression is typical of the generalised confusion we are living in. What is the goal of life? To die rich, or to live happily? Competition or cooperation? Most of the countries have changed their name of their 'Ministry of War' to 'Ministry of Defense' without modifying anything in their structure. In the wake of face lifting, the 'Ministries of Public Instruction' that taught education are replaced by 'Ministries of Education' only dealing with instruction and have become, under economic pressures, mere employment bureaux. The result is millions of jobless people who know how to safely pressurise acetylene or split atoms, but have never heard of Plato. Pleasure, a selfish satisfaction, can be bought. It has replaced joy in the heart of families, under the overwhelming influence of advertising. For the same reasons, science and technology are confused in the minds of adults as well as children; science anticipation is replaced by science fiction, as in electronic games. How can young men and young women of today, wishing to play a role in the construction of the future, hear with the absurdities of our social organisation? How can they tolerate that sophisticated weapons be officially sold as if they were harvesting machines, under the pretext of creating jobs or to fight international competition? How can they accept that this program results in enriching the rich and impoverishing the poor? Or even, in some countries, like France, accept that governments at the same time produce and advertise cigarettes and tobacco, while financing a campaign against tobacco?
When words have lost their original meaning, when simultaneous political decisions are often contradictory, when information becomes universal but unreliable, citizens lose their fixes, become temporarily intoxicated, but may wake up to violent protests. The public must be associated as an adult, responsible partner in all difficult decisions such as the acceptance of certain risks. All human enterprises may fail. Airplanes fall. Gas tanks explode. Nuclear plants themselves have proven not to be safe against mechanical or human failures. It may even be possible that with the fifty kilograms of enriched uranium missing in official world inventories, unidentified terrorists or an irresponsible national leader may use the ultimate atomic weapon. In the meantime, red and green mud are dumped into the sea, ships flounder with the loads of arsenic, nerve gases or defoliants; black tides multiply at a rhythm of almost one a week.

Scientific and technical progress have successfully fought sickness, increased the average lifespan and improved comfort, while inevitably generating some risks. But among these risks, we must decide to refuse those that have irreversible consequences, and to minimise the others. It is urgent to introduce in international politics, a new concept - the management of risks. This management of risks necessarily includes the evaluation of the consequences of possible accidents - not only in the short term but also in the long term.

This management thus begins by choices that must eliminate all the risks that have a chance, even minute, to threaten the essential survival of our species.

The tragedy is that technocrats believe that the public is not able to understand problems, that we have to be talked to like ignorant children, that the technicians are the only ones who know what to do. It is not true. They don't know what they are doing.

In spite of the arrogance of technocrats, we want to know the truth when an accident occurs. We want it to be the right of all people to decide what risks they will or will not take, to protect the quality of life for future generations. However serious problems are, such as pollution, desertification, depletion of the ozone layer, warming up of the planet, transportation of dangerous materials by sea or by air, or elimination of living species, we remain practically unaware of the main cause of all the threats that menace our planet and our future - the population explosion. The fact that this momentous danger is never mentioned by leaders demonstrates the seriousness of the confusion I mentioned earlier and in which we now struggle.

On the 30th September last year, I gave a speech on overpopulation at the United Nations. At the end, the head of UNFPA, Dr Nafis Sadik, gave me a computer that automatically counts the excess of births over deaths worldwide. It was only 281 days ago.

My display shows that during those nine and a half months, the population of the world increased more than 63 million - much more than the population of France! In my lifetime, the number of people tripled from 1.5 billion to 5.5 billion. In 40 years, it will reach 10 billion!

Almost all our social evils, famines, shocking differences between rich and poor communities, desertification, decrease of biodiversity, increase in the number of hereditary taints, and even the warming up of our planet, originate in the population explosion. And that explosion is due to the fact that our new set of antinatural values - generosity, solidarity, pride of our first medical victories on traditional evils - had been enthusiastically applied long before we developed their logical counterpart, birth control. Our lack of synchronism between part and counterpart shows that we have been very slow to understand that our revolutionary new course, replacing harsh natural rules by our own ideals of equality, fraternity, justice, implied new duties and perils. From victims of nature, we had to become relentless protectors of nature. By refusing for ourselves the Law of the Jungle, we committed ourselves to making sure that the natural vegetal and animal kingdoms around us would still benefit from that very Law of the Jungle they cannot survive without.

We have not yet fully realised that our recent divorce from Nature, is irreversible. Our ancestors have long ago burned the bridges and there is no possible return to nature. This implies for modern man the overwhelming burden to invent from scratch a behaviour at the same time acceptable

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**Pétition pour les droits des générations futures**

La surpopulation et le débordement des activités humaines font peser une terrible menace sur notre descendance.

La Déclaration de droits de l'homme — qui proclame la liberté et l'égalité de tous — a deux siècles. Ce texte magnifique ne suffit plus. Nous exigeons que soient solennellement déclarés les droits des générations futures afin que tous les hommes héritent d'une planète non contaminée où toutes les formes de vie puissent s'épanouir.

En signant la pétition de l'équipe Cousteau, je demande aux chefs d'État du monde entier d'exercer toute leur influence pour que la Déclaration des droits des générations futures soit prise en compte par les Nations unies.

Nom ____________________________  
Adresse ____________________________ 

Prière de renvoyer la pétition à:  
Équipe Cousteau — Pétition 75089 Paris  
Cedex 17 France

Equipe Cousteau
biologically, and satisfying for his moral ambitions. If we want our precarious endeavour to succeed, we must convince all human beings to participate in our Adventure, and we must urgently find solutions to curb the population explosion that has a direct influence on the impoverishment of the less favoured communities. Otherwise, generalised resentment will beget hatred and violence.

Our rejection of the Law of the Jungle came from our mind, not from our genes. Somehow, in the complex structure of our DNA is engraved our instinct to submit to the harsh laws and principles that have made the success and the diversity of life. The moral laws and principles that we have inherited, preferred and adopted will take a long time to conquer our genetic heritage.

We realise now that the subtle trail of our original wildcat nature has been saved, has grown and finally blossomed in the Free Market principle, the cornerstone of all our modern economy. The Free Market economy is by far the most efficient system. The collapse of the communist world is mainly due to the fact that in competition between East and West, the liberal economy of the West was much more efficient than the planned economy of the East.

However, once the East-West competition is over, a closer look leads to unanswered problems. Efficiency? What for? To boost the wealth of the rich fifth and sacrifice the poorer four fifths of human kind? Efficiency to favour the currency speculators? Efficiency to increase unemployment, to create millions of people in the richest countries? To waste resources here that are lacking elsewhere? Efficiency to provide youngsters with only one moral idea – get rich?

As long as the Free Market economy will not be far more severely controlled and submitted to our new set of Moral Values, it will be as cruel, as unjust, and will kill as often as the Law of the Jungle we have rejected.

Today, everybody agrees that Power – political, economic or industrial power – is only justified if it serves the people. And the people, finally emerging from ignorance, but drowned by a flood of incoherent information, are struggling in an ocean of confusion. They need clarification, they need to know the facts, even bad news; they have been lied to so often that they don't trust their leaders, their representatives not the media. And the relationship between Science and Media is at least as confused. The two communities do not speak the same language, and a few specialised interpreters are not sufficient to reassure the public. The new responsibility of scientists is to help change such a dangerous lack of faith, to dissipate confusion of the minds, to restore confidence in our destiny and individual pride in every human being.

Prince Albert of Monaco, a world renowned oceanographer, has been a major inspirational force in my life. He brought back from his expeditions information about marine life forms undreamed of before. But his commitment to understanding the world around us did not stop at merely answering a question to his satisfaction. He would personally ride a motorcycle from Monaco to factories in the suburbs of Paris in the late 1800's and talk to the workers, telling them of the importance of the ocean to the future of mankind. A prince mingling with the workers to tell them about science.

What an example for both scientists and newspeople! What a consideration for the average citizen!

The world can no longer survive without the help and total commitment of us all. Isolationism is unacceptable. Scientists themselves are absolutely vital to translate highly technical issues to all those who will elect or choose decision-makers. The public needs help. Citizens of the world must understand the consequences of – and the alternatives for – every course of action. But just the factual knowledge is insufficient by itself. There are moral and ethical issues which cannot be ignored.

The success of the Rio revolution is in our hands. We are millions of human beings, inspired by the Rio spirit and ready to serve as apostles to improve the habitability of our dear home, the Earth.

But threatened as we are by the imminence of the disasters caused by the uncontrolled and accelerated population growth, we all agree that education has become our last recourse. Education of children, of students, of adults, with an emphasis on women and girls, education to restore the pride and the dignity of every human being, rich or poor. Do we have time, do we have the means to successfully win this formidable challenge? Is it feasible to train children from all breeds without severely harming the precious diversity of cultures all over the world? The global generalisation of food, beverages, instruction, communication, literature and art, all inspired and imposed by economic imperatives, jeopardise the generous intentions born in Rio.

The trivial obstacle of the cost barrier is always underestimated in all official projects. Today 600 million children lack adequate education, or even any kind of education! To provide one pencil to all those kids would cost 6 million dollars! To provide one very cheap schoolbook would cost 200 million dollars. And the schools themselves must be built, teachers don't exist in sufficient numbers. No electronic device can even be considered! If the affluent communities were to decide to make the enormous sacrifices necessary, we would also be obliged to face the fact that the population explosion would in thirty years bring the number of children needing help from 600 million to 1 billion 200 million!

Let us not forget that what is at stake is who will win the race between schools and cradles – between an orderly human community, or chaos. We can only win this challenge if we have the courage to face such realities without flinching.

Commandant Jacques-Yves Cousteau, a world renowned speaker and author, has kindly given permission for the text of his address at the Project 2000+ International Forum to be published in Science Education International.

Cdt Cousteau would like to draw to the attention of readers the Petition (for a version in French refer to the previous page) for the Rights of Future Generations which is reproduced on the next page.
PETITION
FOR THE RIGHTS
OF FUTURE GENERATIONS

Overpopulation and the excesses of human activities are posing a terrible threat to our descendants. The Bill of Rights, which proclaims freedom and equality for all, was written two centuries ago. This magnificent text no longer suffices. We solemnly demand that the rights of future generations be formally declared in order that all people may inherit an uncontaminated planet where life may flourish.

Jacques-Yves Cousteau

By signing this petition, I request the leaders of nations worldwide to exercise all their powers that the Bill of Rights for Future Generations be adopted by the United Nations and become part of their charter.

NAME (in capital letters)                        ADDRESS                        SIGNATURE

THE RIGHTS OF FUTURE GENERATIONS

Article 1. Future generations have a right to an uncontaminated and undamaged Earth and to its enjoyment as the ground of human history, of culture, and of social bonds that make each generation and individual a member of one human family.

Article 2. Each generation, sharing in the estate and heritage of the Earth, has a duty as trustee for future generations to prevent irreversible and irreparable harm to life on Earth and to human freedom and dignity.

Article 3. It is, therefore, the paramount responsibility of each generation to maintain a constantly vigilant and prudential assessment of technological disturbances and modifications adversely affecting life on Earth, the balance of nature, and the evolution of mankind in order to protect the rights of future generations.

Article 4. All appropriate measures, including education, research, and legislation, shall be taken to guarantee these rights and to ensure that they not be sacrificed for present expedients and conveniences.

Article 5. Governments, non-governmental organizations, and the individuals are urged, therefore, imaginatively to implement these principles, as if in the very presence of those future generations whose rights we seek to establish and perpetuate.

For Europe, Africa and Oceania, please return the petition to:
Equipe Cousteau - Petition 75809 Paris Cedex 17 FRANCE

Photocopies are accepted

The Cousteau Society
Scientific and Technological Literacy for All
A Perspective Reality

by Thomas R Odhiambo

This article is a plenary keynote address delivered on 8th July 1993 at the International Forum for Project 2000+: Scientific and Technological Literacy for All, Paris, 5-10 July 1993.

While education is taken to comprise ‘organised and sustained communication designed to bring about learning’, literacy implies an ‘attainment of comprehension through a basic educational process’. In the world of today, a basic comprehension of scientific knowledge and technological skills has become an imperative for personal growth and national development. It is in that sense that the call made by the World Conference on Education for All (held in Jomtein, Thailand, March 1990), in directing attention to the urgent necessity for creating a world community of scientifically and technologically literate citizens, was so apposite and timely.

To achieve such a goal would require of the education, both formal and non-formal, of the entire spectrum of the population – all children, youth, adults, and old folk. Indeed, scientific and technological literacy among the old people in Africa is critical – for three main reasons. First, the continent is characterised by the extended family system, in which the grandparents assume a pivotal role in terms of family traditions, community lore, the transmission of experiential knowledge to the younger generation, and the upholding of yardsticks of excellence and societal expectations. Even though, by 1990, the old only comprised 6.0% of the total African population – in contrast to a larger proportion in the rest of the world (UNESCO, 1991) – they wield enormous influence on the eventual turnout of successive generations. Second, Africa possesses a rich diversity of languages that is found nowhere else in the world. Eschewing dialects and regional variations, Africa has more than 2050 indigenous languages – all demonstrating a varied tapestry of poetry, song, ballads and verbal repositories of natural histography, applied sciences and technology, and philosophical musings and political economy. Thus, Africa has been always intensely literate in oral tradition, and in reading verbal and body language, whereas the written literacy has been spotty throughout the 7000 years of African civilisation, from the Pharaonic times to the present. And third, the comprehension of science is not absolutely tied to the understanding of mathematics ‘of abstract and logically rigorous formulation’ (Medawar, 1967). The essence of understanding of science consists ‘in becoming aware of what is there, in nature’ (Medawar, 1967). This sagacious view is shared by Enrico Cantore (1977) in his book Scientific Man where he states that ‘science constitutes an essential factor of the historical development of man as a cultural being . . . I began to perceive that science is human not because it is produced by man, but also because it is in itself an agent fashioning man in culturally new ways’ (Cantore, 1977). To treat science as merely a tool, a handmaiden for development, or other variants of instrumentality, would be both shortsighted and short-handed; know-how alone would lead Africa nowhere. Africa’s sense of sagacity is vital.

Science is more than a tool

Such a paradigm is well expressed in an important area of Africa’s traditional knowledge base, which cannot be ignored in building a modern agricultural science and practice in the continent. This view was strongly expressed in a recent gathering of agricultural scientists and African farmers in Nigeria:

‘. . . the traditional knowledge base grows and develops through the accumulation of new experiences and the tested results of experimentation and repeated observations. It is evolutionary in character, but it is nonetheless solidly based even though it does not necessarily grow through the analytical methodology of science. The challenge for the African agricultural scientist is to be able to understand and rationalise this vast traditional knowledge base so as to have a systemic foundation on which to build a truly African-oriented science-based agricultural practice.’

Thus, agriculture in Africa should not only be conceived as instrumentality for earning a living. In the African context, where farming still commands the services of a very large agrarian population (from the least in Mauritius and Egypt, of 19.0% and 32.8% of the entire national population, respectively; to the normally high proportion as reflected in Senegal and Rwanda, at 80.6% and 92.8%, respectively) (UNDP, 1991), agriculture ‘must regain its capacity to provide a challenging and worthwhile way of life: an agrarian environment should not only be farmed, it should also be worked, perceived, known and lived. In short, we are looking at farming as a way of life rather than merely a source of employment’ (Odhiambo, 1992). In this milieu, the sagacious old people in the agrarian environment are able to impart a holistic sense of rural life that may well attract the youthful and the new literates to stay put and work at enjoying a fuller rural life.

The problem of the youth in Africa, that is those who are 15 years or below, who will have attained middle-level leadership roles by the year 2020, is extremely difficult in relation to the kind of education and training they should undergo in order to fulfill those roles. The scale of the problem itself is horrendous: in 1980, these under 15 year olds constituted a massive 90.3% of the population; in 1990, it escalated to 92.8%; moreover, there are only two working-age African adults for every school-age child, in contrast to a ratio of 1:5 in the industrialised North (UNESCO, 1991). The African population in 1990 was
approximately 648 million; at that time 240 million (or 37% of the population) constituted the labour force. The proportion of the labour force, those between 20 and 34 years old, in the year 2000 will rise to 42% of the total population. In the year 2025, the proportion of the African labour force will rise to about 45% or 650 million out of a total expected population of 1.6 billion. During that same year, the entire labour force in the industrialised North will comprise only 636 million (IMPACT, 1991). The current education system in Africa has achieved a great deal in the three decades since the great era of political independence, mostly in quantitative terms and in its phenomenal expansion from the secondary to tertiary levels. But these achievements have not kept pace with the quality expected from it, nor its relevance to Africa’s modern needs in a vastly competitive world which has left Africa, used to big-power protection and development aid, virtually alone and ignored. Africa needs to look afresh at the philosophical and operational bases of its education system – formal, informal and non-formal – and to deliberate on how to achieve the national and continental goals that the system is structured to attain.

Currently, the literacy rate in the continent is appalling. Adult literacy rate is a mere 45%, and even in countries with an old tradition of learning such as Senegal and Egypt, the literacy rate is only 32.1% and 44.6%, respectively (1985 estimates), with mean years of schooling a paltry 0.7 and 1.7 years, respectively (1980 figures) (UNDP, 1991). This relatively low rate, closely associated with the high density of material poverty in the continent, probably explains the comparatively low life expectancy of 51.8 years. What is most troubling, with a long-term impact level, is the paucity of scientific and technological capacity in the continent. Most countries in Africa, including Egypt, have less than 3 scientists and engineers per 1000 population (1980-1988 figures); and there are, on average, only 7.7% of the workforce employed in the industrial sector (UNDP, 1991). It is clear that the various national programs of universal primary education have achieved, or are approaching to achieve, quantitative goals that have been set; but they have left a yawning gap in scientific and technological literacy at the very top – with less than 26% university graduates qualifying in science-related subjects (UNDP, 1991) – and have shown abject failure in developing a quality content for this basic level of education. The World Bank perspective study, Sub-Saharan Africa: From Crisis to Sustainable Development (1989) has not minced words (World Bank, 1989). Quality has yet to be assured in primary education. Content is of low quality and relevance: indeed, ‘tests on reading comprehension, general science and mathematics suggest that many African students are learning very little’. Very little is spent on educational materials; on average, US$0.60 per student a year in Africa, in contrast to a basic requirement of US$5.00. And there is very little capacity to develop and fabricate low-cost teaching materials conforming to the requisite learning expectations (World Bank, 1989). Yet, education, particularly science and technology education, is intrinsic to modern social and economic development.

A profound change in this scenario can only manifest itself if the geopolitical leadership, the policy community, the scholarly and scientific community, and the business-industrial sector jointly and deliberately take a long-range strategic decision to break with the past, and adopt a vision of what the continent needs of its leadership.

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Nominations for these awards must be forwarded by member associations of ICASE. For full details of how to forward nominations, contact the Executive Secretary below.

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**ICASE Association Award**

This award recognises individuals who, within their science teacher association, have made a significant contribution to the international activity of their association.

Contact Dr Jack Holbrook, Executive Secretary ICASE
72B Blue Sea House, 28th October Street, Limassol, Cyprus
by the year 2020. If the continent is to achieve a universal literacy in science and technology by that time, then it has to begin to deliberate along the lines that the Africa Leadership Forum, in its declaration formulated in The Kampala Document has highlighted. The declaration begins by stating that 'people are both the means and the desired end of the benefits of development. Africa's development is principally hampered by inadequate human capabilities' (Africa Leadership Forum, 1991). It then goes on to prescribe what to do:

- Illiteracy should be eliminated across the continent by the year 2000.
- Africa should adopt national systems of meritocracy; and should therefore adopt attractive levels of incentives and compensation for professionals and public servants, so as to curb the growing brain-drain, while ensuring that African talents in Africa are used in preference to foreign experts. In this respect, Africa should establish a bank for Africa's human resources and skills.
- Science and technology should be introduced at an early age into the national education systems.

Such thinking, as illustrated by The Kampala Document, needs to grow into a general public debate throughout Africa. Programmatic proposals which do not comprehensively examine both the process and the objectives are unlikely to make a deep impact. For instance, the electronic media have been touted as a possible option for mass education in Africa. Yet, as K'Omodho states in a recent paper to environmental journalists in Kenya, despite the current communication explosion, 'do we effectively communicate with our people? the huge investments by governments in the mass-media have not yet yielded real expected benefits, those of a people eager and willing to work for development' (K'Omodho, 1990).

Indeed, political will and purposeful leadership in matters of science and technology education, in furtherance of the empowerment of the entire population to engage in science-informed development, is what had distinguished Africa from its Asian co-developing countries, who are far outstripping it in this sphere. Forty years ago, the two continents had comparable living standards. How has Asia moved ahead, out-distancing Africa in the process? The InterAction Council, in its report of a high-level meeting it convened in Cape Town, South Africa, in January 1993, has reached a most revealing conclusion (InterAction Council, 1993). Apart from implementing a green revolution-type of agriculture, which gave the South-East Asian countries food security as well as permitting them to diversify their agriculture, and apart from adopting an aggressive and highly competitive export-oriented economy which diversified into light and advanced industries, and in addition to having stable governments, these countries have a high-quality education system for all, which produced an adequately educated and skilled labour force as well as a managerial class capable of absorbing technology and investment. This modernisation experience could be a model for Africa — without the continent de-banking its traditional values and experiences, as the Council states convincingly (InterAction Council, 1993):

"To release people's energies, Africa needs to bring back its own values, culture, identity and structures, to be confident in itself, to build on the people's sense of themselves . . . and to develop their capacity to think and act for themselves.

Development cannot be and should not be seen as something handed down from outside, but something emanating from within."

This lesson is hammered home by a South Korean political scientist very much involved in the Korean industrial resurgence, Dr Mark Suh, in his guest lecture to the Annual Research Conference of the International Centre of Insect Physiology and Ecology (ICIPE) in Nairobi, Kenya in May 1993, on 'Science and Technology Policy of Japan and Korea: From copy to self-reliance', when he concluded (Suh, 1993):

"The experiences of Japan and Korea indicate that the adaptation and utilisation of Science and Technology were essential for economic as well as social advancement. This required central planning and effective management of human as well as natural resources. Education played a very important role in producing needed scientists and in adapting and advancing foreign technology. Japan and Korea internationalised their economies rapidly without losing their own culture and social structure. The examples of these two countries' path to development through technological advancement and independence can serve as a guide to countries now faced with the great task of determining the most appropriate means of development."

There is no doubt that building an independent national and regional capacity in science and technology, able to create, adapt and utilise new results from scientific research and technological development (R&D), together with the entrepreneurial and managerial capacity to transform this knowledge and know-how into technological products and social services, is a prime requirement for the rapid economic and social advancement of the continent. Foreign aid — and even multilateral assistance — can only catalyse this process; it cannot be the sole prop for this very societal responsibility of the continent itself. United States Congressman George Brown has put it succinctly in characterising United States' aid for science and technology to developing countries (Brown & Sarewitz, 1991):

"In spite of such examples [of previous S&T aid to South Korea and other South-East Asian countries], efforts by the United States to promote economic development abroad have never included a comprehensive approach to science and technology. Although 'technical assistance' has been an integral part of US development aid since the late 1940s, it has not served to foster an independent S&T capability in developing nations. Moreover, the S&T budget for the Agency for International Development (AID) is almost entirely devoted to research carried out by US scientists on specific, and often urgent, developmental problems, not to institution-building. Of the $300 million operating budget for AID's S&T bureau in 1991, a mere $150 000 was slated for joint research with scientists from less-developed countries."

Thus, United States policy continues to focus on supplying
technology and US expertise to developing countries, rather than contributing to indigenous science and technology capacity.

The published word
The public debate on science and technology for national and regional economic and social development is only starting in Africa. The decision-makers, the opinion-makers, the money-makers; the geopolitical leaders, the geoeconomic leaders, the scientific and technological leaders; the civic communities, the agrarian communities and the workers communities — all need to be engrossed in this debate. This requires a comprehension and perspective view of science and technology of an entirely different order from what we have now.

Apart from the oral literacy in which Africa excels, it must also now embrace the written-and-reading literacy. The book, especially the science and technology book, must become a life-long friend and a fountain of knowledge and inspiration — rather than a route to success in school and college examinations. Yet the publishing world in Africa is a very poor world indeed.

There is, undoubtedly, a book famine in Africa. There are very few indigenous publishers of any significance in the continent. During the period 1985-1989, only four publishers in Kenya produced children’s books; in 1989, a mere total of 22 titles were published in the entire country. During the same period, a total of 1045 titles of all categories of books (textbooks, religious books, leisure books, etc) were published. Of these, only 25% were written in Swahili and other African languages. With about 300 languages spoken in Kenya, it is certain that the great majority of the people are not literate in their own languages — which are the carriers of their culture, mores and traditions, and on which a modern science culture should be grafted.

Although there have been many attempts by international organisations and aid agencies to foster an indigenous publishing enterprise in Nigeria, Ghana, Zimbabwe, Kenya and many other countries in Africa, a robust, confident, indigenous publishing world has still to make its entrance felt in Africa. In this situation, a concerned publishing consultant based in London, Hans Zell, was impelled to state the obvious line of needed action (Zell, 1992):

"The scarcity of books has meant that neither the needs of educational institutions nor of the general public can be met. Devastating and quite possibly lasting damage is being inflicted across a whole generation going through primary, secondary and university education in Africa today."

The problem is compounded by the fact that the African famine related to science literature is even more profound than that afflicting the general book availability in the continent. In a survey published in 1990 by the recently established Council for the Promotion of Children's Science Publications in Africa (CHISCI), of science publications available for children below 14 years in bookshops in Nairobi, just over half of the titles were published in East Africa, and of those only 1.69% publications were written in African languages. The paucity of mother-tongue science publications for African children is extremely serious, as it confirms the prevalent view that science is not part of the African culture. The principal motivation of CHISCI is to re-integrate science into African culture, since the current educational system does not relate science to everyday life, to household community life and to future livelihood. The Preface to the Survey concludes (Odhiambo, 1990):

INARTICULATE SCIENCE?
Perspectives on the Public Understanding of Science and Some Implications for Science Education

by David Layton, Edgar Jenkins, Sally MacGill & Angela Davey

The public understanding of science is a matter of concern in most countries. This is not simply because educators or scientists wish to promote a wider understanding of scientific ideas as worthy of the attention of all thinking citizens. Such understanding is commonly regarded as essential for the effective implementation of a wide range of social, economic, technological, medical, employment or other policies which have a scientific dimension. This book explores the ambiguities and limitations of the concept of 'public understanding of science' and, by means of case studies, addresses the meanings and social uses which science has for members of the adult public who are not themselves professional scientists. Drawing upon a substantial literature to place the case studies in a broader context, the final chapter examines the implications of the research for science education.

Published by Studies in Education Ltd, Nafferton, Driffield, YO25 0JL, UK
ISBN 0 905484 55 X, 159 pp, Price £9.95
"There may be many factors that could have led to this situation which could be attributed to economic situations in third world countries. However, CHISCI tends to be of the opinion that developing African countries have given this excuse for too long and this persistent shrouding of the problem has inhibited a lot of possible growth and development in many aspects including education. Science, in the context it has been put to the African Society, does not attract much attention... The best way to reverse this situation would be to inoculate science education at an early age."

Prospect

If science and technology is, indeed, to form an integral component of an African culture and to imbue it with its own genius and vitality, African educational systems — whether formal or informal, whether non-formal and on-the-job — must be able to speak, write and think science and technology in the language of the household, as a process of re-integrating science and technology into everyday living and lifelong cultural interaction, at the same time that the international language of science and technology — in its international dialogue and trade — continues the international tradition started in mid-nineteenth century, of communicating in English, French and German.

In this way, Africa will find a new harmony in their being at peace within themselves, while facing — at the same time — the competitive world of modern science and technology-dominated livelihood.

In the words of Sabra, in the Preface to his book on 'Theories of Light' (Sabra, 1967): "I came to see in the history of science the history of man's most imaginative and most rational enterprise." Africa needs to share in this exciting and rational adventure.

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Science Education in Developing Countries
What's the Point?

by C J Stoll
Centre for Development Cooperation Services
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Introduction
There is no doubt that the situation of mathematics and science education in many countries is in urgent need of improvement. Likewise, there is no doubt that a considerable amount of research has been done worldwide on basic issues of teaching and learning mathematics and science. Yet, the increasing level of our understanding of conceptual development so far has not been paralleled by an equal increase in the quality of science teaching. Problems of implementation persist worldwide and are perhaps most noticeable in the majority of the developing countries. In industrial countries there also is a huge gap between the desired state of math/science teaching and actual classroom practice.

At a recent conference on 'Science education in developing countries: from theory to practice' (Jerusalem, January 1993) the case was put forward by some that more attention should be given to the problems of science education specific to developing countries. In contrast, others argued that science education is an academic subject in its own right, and that the laws of Newton do not differ from country to country and neither do the difficulties which learners may have in understanding them. This dispute calls for an attempt to consider the question of 'what - if anything - is special about science education in developing countries'. In the following paragraphs some thoughts are given to this question, especially with respect to matters of teacher training and curriculum development.

The nature of the problem
The wave of post second world war decolonisation has led to many independent nations which had to develop their own educational systems on the basis of the pre-independence foundations. A common feature which is almost invariably connected with the post-independence educational efforts of these countries is the dramatic increase in enrolment figures in the educational system. Universal Primary Education is high on the political agenda of most countries (and rightly so!); this has led to an unprecedented expansion of many education systems in periods of time hardly exceeding one or two decades. The expansion of the primary education system has, with some delay, put an even stronger numerical pressure on secondary education. Figures from the World Bank Study on Education in Sub-Saharan Africa (1988) show that between 1960 and 1983 the educational systems at the primary level on average expanded by a factor of 4, and at the secondary level expanded by a factor of 14 ! The dramatic shortages of teachers which resulted from the steep increase in school enrolments have compromised the quality of the system often beyond the level of acceptability. In addition to teacher education not being able to retain quality with rapid expansion, the appeal of the teacher profession also declined, resulting in weaker students entering teacher education programs.

Among the numerous consequences of this educational policy, quite a few factors have a bearing on the situation of mathematics and science education at the secondary level. It should be noted in this respect, that in most countries the teaching force at primary level predominantly consists of generalists (one teacher per class, teaching virtually all subjects) whereas the teaching force at secondary level predominantly consists of subject specialists (many teachers per class, each teaching his/her own subject). At primary level, the vacancies are often pushed in a downward direction, the more competent teachers teaching the higher grades, leaving the lower grades for underqualified teachers and temporary stand-ins. At secondary level, however, the shortages of teachers may vary per subject, but are always largest in the mathematics and science subjects. Not only the numbers of students are low who opt for a career in science and maths because of the relative difficulty of these subjects, but also the economies in many countries are in strong need of science-based manpower in the government and private sector. As a result, the individuals who would qualify to teach science and maths in the secondary school system tend to 'evaporate' to greener pastures. Indeed, many of the less industrialised countries are struggling with the problem of an unstable and underqualified teaching force for the science and maths subjects, which are most crucial with regard to agricultural and industrial development. This situation profoundly affects any attempts to boost human resource development in the field of science and technology. For example, the scientific and technical manpower potential per million population was estimated (1985) to be 130 000 in North America as compared to 1300 in Sub-Saharan Africa (UNESCO, 1989).

The teaching of science and mathematics subjects by teachers who are insufficiently qualified to teach these subjects at the level they are required to do, often leads to a rather rigid teaching style with a minimum of interaction between teacher and learners: the less confident a teacher is in a particular topic, the more he or she is inclined to 'chalk and talk', sticking closely to prepared notes at best, and avoiding to deal with questions which might reveal the marginal level of understanding the teacher himself has of that topic. The response of learners in such cases usually is to rely on rote learning of the topic at hand. Many learners are finding their
way towards the final examinations on the basis of learning by head standard answers to standard questions, without a clear notion of why these answers are correct.

Furthermore, the curricula and accompanying textbooks inherited upon independence by many countries are of western origin. They often were adopted in full — for all practical purposes. Yet, not all syllabi which have a strong relevance for the average school in, say, Germany, are necessarily of equal importance to the average school in Zaire or Bangladesh. Moreover, even standard topics which feature in virtually all curricula should be presented in a local context. However, in many cases they are not. How then should teachers be encouraged to link their teaching to the daily experience of the learners, if there is such a wide gap between this experience and the educational materials they are provided with?

On top of that, here also the language issue comes in. In order for learners to build new concepts into the existing framework of reference it is of crucial importance that the learners should be able to discuss in their mother’s tongue all features and examples familiar to them which could contribute to attaining a full understanding of these new concepts. I think it is hardly possible to overestimate the importance of the role of the language and the selection of books in the teaching and learning of mathematics and science, the more so when the language of instruction is a second (or even a third!) language for both teachers and learners, as is the case in many of the developing countries. Last but not least, it should be realised that the budget available for science education is a factor which is extremely variable throughout the world. It will be no surprise to find that rich countries can spend more money on education than poor countries can (UNESCO, 1991), but it may be useful to bear in mind the fact that the poorest countries can spend less than 3% per pupil per year of what the rich countries do (i.e. approximately US$100 on average in 70 ‘developing’ countries, versus approximately US$3000 on average in 30 ‘developed’ countries). This not only has its negative effect on the remuneration of the teaching force, it is also reflected in the material conditions in the schools. Material conditions can be the mere availability of such basic things as classrooms, laboratories and furniture, but also the educational materials such as books, laboratory tools and demonstration apparatus.

Related to this are important considerations such as the organisation and management of schools and the effective use of teaching time, provision of facilities for making homework, etc. Moreover, the material conditions which affect the success of science education are not only the conditions prevailing in the schools, but also include material aspects of the learners’ lives such as nutrition condition, distance to be travelled (walking) from home to school and the conditions at home for studying and making homework.

Summarising then, the type and the magnitude of the problems which many of the developing countries are facing are unheard of in most industrialised countries, where the bulk of the research into cognitive problems and process
skills related to science education is taking place. It seems to me that we are missing the point if we try to contribute to strengthening science education in developing countries without addressing with some priority the issues raised in the previous paragraphs. Notwithstanding the high standards and the professional relevance of the bulk of the research in the field of science education, which are fully acknowledged and which should be given full credit, the issues studied are not always necessarily the most urgent ones as seen from the perspective of many developing countries.

Options for interventions
Some may well argue that it is not difficult to identify the solution to the majority of the problems described in the previous paragraphs: it is money. In this sense there is little the academic community of science educators can professionally contribute to solving the problem. However, in my opinion this issue cannot be dismissed as a non-issue. Quite to the contrary, it is only realistic to recognise the fact that this overriding problem in many countries will not be solved in the foreseeable future. It is necessary, therefore, to direct more efforts to the question of how to improve the quality of the teaching-learning process in situations where the social and material conditions constitute an extremely limiting factor. In the following paragraphs I will make an attempt to identify some areas in which the use of professional expertise in the field of mathematics and science education could play an essential role in addressing the problems in these fields in developing countries.

Interventions aimed at strengthening the teaching force
First and foremost, strategies should be designed which in the long run will lead to an increase of the numbers of mathematics and science teachers. In some southern African countries a number of donor-supported projects have been specifically targeted towards a steady increase in the numbers of students at the tertiary level with a math/science background (Dulfer & Thijs, 1993). Special bridging programs have been developed for disadvantaged students who failed to meet the requirements for regular entry into science based studies at tertiary level. These programs are of a remedial nature and offer an alternative route to potentially able students to pursue a science based career. In this way a process has been set in motion that tackles the vicious circle of a shortage of science students at tertiary level perpetuating the shortage of science teachers at secondary level, etc.

Second, proper attention should be given to the professional quality of the teaching force in terms of mastery of subject content. The very trivial observation that self-confidence in (school science) subject matter is a pre-requisite for good teaching more than any other factor (v.d.Berg, 1993) should have a bearing on teacher training curricula. Too often the curricula for training of mathematics and science teachers consist of a loosely designed package of university courses from a BSc degree program and elements of educational foundations, which does not specifically prepare the students for the teaching of secondary school mathematics and science. In many countries there is an urgent need for more targeted curricula for science teacher training (Ware, 1992). This statement also applies to teacher education in industrial countries (McDermott, 1990).

Third, ways should be found to improve the teaching-learning process, both in terms of educational effectiveness and in terms of local relevance (which are, of course, two sides of the same coin) (Knamiller, 1984; Lunetta & van den Berg, 1993). Regular in-service programs for maths and science teachers have been mounted in various countries in Asia and Africa which aim at supporting the teachers in acquiring a more solid professional background and a more challenging teaching style. Strengthening the morale of teachers, developing leadership in curriculum innovations and supporting the initiatives of professional associations of mathematics and science teachers are further tools which may be effective in promoting the case for science education.

With respect to these three crucial issues, the focus of 'science education in developing countries' should be on studying the effectiveness of a variety of possible interventions (or a combination of these, de Feiter, 1993) aiming at a greater stability and a stronger professional quality of the teaching force. It has been widely recognised (Knamiller 1984, 1992; Lewin 1992, 1993; Walberg, 1991) that all of these points offer a wide range of professional questions to be addressed in more detail, most of which are country specific, or at least show marked differences from region to region. Here is a role which science educators could take up with more vigour than hitherto has been the case.

Interventions aimed at developing a relevant curriculum and accompanying educational materials in a local language and local context
In each country it is important that the curriculum selected should be viewed in the context of the national educational system as a whole. What purposes is it supposed to serve? Is the curriculum predominantly meant to prepare the learners for taking up further academic studies for which mathematics and science are a prerequisite, or should it prepare school leavers who do not intend to pursue an academic career for life in the social and economic context pertaining to the country concerned? What types of science education curricula are best meeting the educational demands of a particular nation, and how large a diversity of curricular options is desired for a country so as to derive the maximum benefit from its investments in the educational system? In the last decade, indeed, many countries have embarked on a process of curriculum reform, both in the highly industrialised countries and in the less developed countries (for a survey, see Ware, 1992).

Not only the design and/or the selection of the curriculum presupposes a thorough analysis of the parameters defining the local situation. The process of implementation, too, can only be the result of an intricate interaction between curriculum developers, pre-service and in-service teacher trainers, textbook writers and examination boards. The development of locally designed trial materials, along with the evaluation of the use teachers can make of these materials, and an assessment of the effects on the performance of the learner, offer a vast field for much needed investigations which should yield the data on which implementation strategies can be based.
Problem of poor material conditions

It is essential to acknowledge the fact that material constraints — within certain limits — can only be overcome by well qualified teachers who are well motivated and resourceful. A weak teacher cannot achieve much, even if the material conditions are relatively satisfactory; a strong teacher can achieve a lot, even in relatively poor conditions. The teacher training process, therefore, is of crucial importance, but the teacher training curriculum should always take into account the limitations of the sometimes harsh reality the teachers will face once they are at post. This is not only a matter of developing low cost equipment, although simple home made teaching aids may turn out to be very powerful demonstration tools in teaching science in a local context (Van den Berg, 1988). It also requires school curricula and teacher training curricula which are designed with the explicit aim to make an optimal and creative use of the limited opportunities the locally prevailing circumstances still offer (Walberg, 1991).

Here, then, is another area to focus upon for science educators: how to develop and improve methods for teaching certain science and mathematics topics in countries lacking the financial resources to adequately equip the schools.

Conclusion

The point I want to make is, that the relatively poor performance in the areas of mathematics and science in many countries in the world is not primarily stemming from an insufficient access to the findings of science educators. The roots of the problems lie in the socio-economic conditions these countries find themselves in. This does not mean, however, that science educators have little to contribute professionally to improving the situation. There is a lot that can be done and must be done for which professional expertise in the field of science education is required. Studies should be directed towards the most effective strategies leading to an increase in the number of science and maths teachers. Within the context of each national educational system, teacher training curricula (both pre-service and in-service) need to be continuously evaluated and readjusted in accordance with the needs of the local society in any given point of time. School curricula in science and mathematics need to be localised and examinations design should parallel this development. Implementation of the intended curriculum innovation requires a thorough analysis of the teaching-learning process on daily classroom practice. Strategies for change need to be developed in consultation with the change agents themselves — the mathematics and science teachers. Building up more expertise in the areas mentioned above as areas of priority is the task of science educators. There is a valid point in 'science education in developing countries', and it deserves proper attention.

On the basis of the thoughts presented above I would like to address the question put forward in the introduction in an open mind. Science education as an academic field of study is a worldwide discipline. It studies the nature of the science subjects and the nature of the problems learners may have in understanding the basic concepts in the various subjects, and it develops teaching strategies for optimising the teaching-learning process. On the basis of this definition there is no need to discriminate between science education in the industrialised world and science education in developing countries.

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Science Education around the World

Member associations and individuals are invited to contribute to this section.
Suitable items include brief accounts of specific projects of international significance, science education in a particular country, or international and regional seminars and conferences.

INTERNATIONAL MEETING
Science Education Journals
Gaeta, Italy, August 1993

Report compiled by Jack Holbrook, ICASE Executive Secretary

Introduction
This international meeting brought together editors of international as well as national science education journals. Several national journals are, due to their distribution, available internationally.

Some journals carry abstracts in three languages. This could be important for any journal purporting to be international. However, it is far more desirable to have the whole article in the language of the reader if the journal is to be of benefit to the reader.

These, and many other issues of interest were discussed. The meeting was divided into four discussion groups. I have summarised the major discussion points, outcomes and recommendations from each group:

1. Discussion, outcomes and proposals: Supporting the author

   Awareness
   • Be clear about the purpose of the journal (eg Is it to improve science teaching in classrooms? Is it to support networks of academic researchers? Is it to give recognition to science education research?).
   • Provide clear guidelines, plus examples of good practice, both in general and specific to content.
   • A database on what journals are available and their emphases would help potential authors to become aware.

   Incentives
   • Have specific subject issues, and invite papers on these.
   • Use national conferences and contacts with schools to encourage teachers to contribute articles.
   • Make provision for authors to 'start small' by establishing special sections for short articles, reviews, notes and comments.
   • Editorial board members should actively encourage contributions and be prepared to give specific advice when required.
   • Make use of tertiary course assignments as a means to obtain articles (ie from pre-service courses, in-service courses, higher degree programs).
   • Consider the use of 'rewards' such as a free annual subscription, or a free copy of a special issue, or even payment for the article (although this is not usual practice).

   Support
   • Help for teachers modifying their manuscripts could be provided by supervisors, researchers, editorial board members, etc.
   • Rewrite a potentially good article completely.
   • The editor to communicate positively and constructively with authors concerning articles which have been rejected or articles which need modifying.
   • Referee's comments to authors should also be positive. This can be achieved by having comments in two parts, one part for the editor only, and the other part for the author.

   Personal follow-up in order to encourage potential authors is useful.
   • Keep authors informed of review procedures and the stage the article has reached.
   • Encourage (even insist) on quick reviews and decisions on whether to publish or not.
   • Establish guidelines which lead to quick publishing of articles once received, eg the time from submission of an article to decision on whether to publish could be set at a maximum of three months; the time from acceptance of an article to actual publication could be set at a maximum of 18 months. This course would depend on the nature of the article or contribution.

   • The language of international journals needs careful consideration. Should it be English only? Should it be English, Spanish and French? Should it be English but with abstracts in other languages? Internationally, English is the most widely used second language and, unless costs permit multiple language versions, it is realistic to expect that English will continue to be used as the language for international journals.

   • To help authors, steps should be taken to review articles in the language of the author and to have the articles translated after acceptance. This may necessitate an international network of referees.

Dissemination
• Articles need to be comprehensible, useable, interesting, relevant, and rigorous.
• Better dissemination to teachers will result if international journals can be linked to national journals.
• Abstracts should be in the language of the author and the journal.
• A circulation centre should be established for abstracts/contents pages
of science education journals, preferably as a national/international database. The centre should receive the titles/abstracts as soon as the manuscript is accepted, rather than waiting until published.

Group 2 Discussion, Outcomes & Proposals: The Nature of Research

Responsibility of authors

- Authors should consider the following process for developing an article for submission to a journal: (1) circulate to peers; (2) present at conferences at a local, regional or international level; (3) communicate the idea of the article to the editor, or discuss with a member of the editorial board; (4) construct a personal review process; (5) collaborate as needed in areas of weakness.

- Authors should locate the study within the expectation of the community of researchers and/or teachers to whom the article is primarily addressed. This includes use of key concepts about which the community has shared knowledge.

Responsibilities of Editors – General

- These include providing feedback to authors; providing feedback to referees; providing information to contributors; accepting citations used by authors who are not known to the editor or the reviewer (eg due to the use of another language); dealing with conflicting judgements from different referees in ways which take into account known strengths/weaknesses/biases of referees; providing advice on format and academic qualities required by the journal (including publishing of exemplary papers, publishing of comments on the quality of such papers alongside the papers themselves, publishing papers on research methodologies, etc).

Responsibilities of editors – Specific to influencing authors’ thinking about and practice of research

- Publish reviews or research in areas to increase the clarity and relevance to teaching and to focus on practical involvements.

- Invite papers that encourage voices from new researchers (eg teachers, culture, nationality, across professions)

- Encourage different voices on new topics and policies.

- Publicise events which bring teachers together with researchers.

- Editors can ask for a review paper to help new authors (teachers, non-speakers of English) understand new research strategies.

- Editors can encourage authors to focus on educational issues and not just research issues.

- Editors can communicate to teachers, the journal’s policy regarding the purpose of research and the style of research.

- Editors can consider whether dissemination of research to teachers be by national or international journals.

- Editors can encourage authors to improve their papers’ ability to communicate to practitioners and professional concerns by considering: inclusion of vivid descriptions of the critical events in classrooms; linkages between principles of education and expression in practice; the personal and social contexts which can cause plural understandings and thus the need for expression of alternative or rival theories that explain practice; the use of simple and direct language avoiding jargon.

- Editors can consider articles which might be used in monographs or special issues.

- Editors can consider including a section for reports written by or in collaboration with classroom teachers, and establish a board of teachers as reviewers for such sections.

- Editors can request the inclusion of implications for practice in articles, or the inclusion of evidence for problems being solved in reports of research.

- An annual review could be written by a teacher or group of teachers or representatives of a national community of researchers directed towards teachers’ concerns and problems about practice.

- A common framework for dissemination of review type articles could be employed across journals.

- Solicit readers’ and teachers’ evaluation of research reported, including discussions of the impact specific articles have on teaching and on thinking about teaching.

- Attend conferences to solicit research papers and elicit the teacher’s perspective on the impact of these papers on their practice.

- Editors’ support of one another in increasing the impact of research articles upon teachers’ thinking and practice

- Share exemplary papers (ie those showing high quality communication

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and/or high quality of the paradigm of research) for discussion among editors, boards and reviewers.

- Collaborate in an action research enquiry into editorial practices, with the aim of improving editors' judgement of quality with special reference to the impact upon teachers.

The evidence may include: anonymised cases of submitted papers which have generated controversy in refereeing and editorial decision-making (eg dilemma between judgements of high teacher relevance vs low academic rigour); personal records by referees to the editor on the thoughts and feelings evoked by the paper (their subjective experience of wrestling with the dilemma); brief account of the reasons leading to the decision made; evidence elicited from teachers who read the anonymised article and report on its impact on their thinking and practice.

The analysis may involve the editor theorising about how the dilemma was solved in each case and what principles are justified to guide the judgement of future cases, and collaborative cross case analysis and testing of principles in action as against criticism of other editors.

Roles and responsibilities of researchers wishing for increased impact of their research upon teachers' thinking and practice

- Consider an appropriate type of involvement with teachers within the spectrum of cooperation and collaboration.
- Establish the relevant agreed power, control and ethical relationships, giving as much as possible to the teacher.
- Assist teachers to create conditions within their own teaching for the conduct of data gathering.
- Encourage the adoption of teachers' own questions, problems and concerns as the research foci.
- Take sensitive account of the culture of the classroom in the task of interpretation of evidence.
- Consider very carefully how to decide what evidence to report and which interpretations to pursue when the complexity of classrooms make so many available.

- Remain open to the many factors which may be relevant in complex classroom situations, and yet work towards a sharp focus.
- Accept that such research will be very difficult, very time consuming, but very important.

Group 3 Discussion, Outcomes & Recommendations: Audience Needs

Audience

- Can any one journal cater for all the needs of university teachers; high school & primary school teachers; researchers; university and school students; educational advisers and policy makers; subject specialists; generalists?
- Are the readers also writers?
- In catching the reader, it is necessary to consider the nature of the captive audience as well as market forces.
- There is a need to balance the needs of readers, writers and editors as follows.
- Specialist needs (in physics, chemistry, biology, university, etc.) vs broad range of interests (all researchers, science teachers, etc.)
- Emphasis and personality of small number of editors (shape and design of journal's direction) vs responsiveness to a large group or organisation (demands of organisation of readers)
- Research and academic articles (what teachers should be reading) vs professional, practical and classroom material (what readers want for their work)
- Service to readers (abstract service, translation to other languages, thematic issues, separate sections) vs service to writers (editorial assistance, offprints, copyright protection, quick response)
- Pro-active (anticipating themes, generating controversy, soliciting articles) vs reactive (presenting members' views, responding to needs, association journal)
- Cost/profit support (subscriptions, fees, government grants, budgets) vs quality and value for money (colour, technical support, more pages, more issues, good paper)

- Voluntary workload (unpaid editors, secretaries, no technical support) vs publishers' provision (fees, time, computers, full time staff)
- Choose key contributors as mediators between science of classrooms and research/practice.
- Other discussion points included more teacher material, consideration of other languages and cultures, review policy to expand and expose ideas, change structures to meet new demands, plan early for themes and debates and new ideas, review quality and presentation, and monitor readers' opinions.

Group 4 Discussion, Outcomes & Recommendations: The Make-up of a Journal

- A summary of journals (teacher-oriented, student-oriented, research) was presented.
- While recognising the popularity of informal/popular science magazines, it was decided not to discuss the role of such commercial publications.
- It was decided to focus discussion on possible modes of collaboration (eg develop a system to share journal title/abstract database; brainstorm ways to provide science educators and teachers with greater access to knowledge; establish communication to facilitate international discourse and collaboration on projects.
- It is ideal situation to have the capacity to freely translate and publish any article at any time; to have the capacity to have multiple/concurrent submission of a manuscript; and to be able to distribute any or all reprints in multiple quantities upon request. The constraints are clearly the copyright laws and the copyright issue depending upon use.
- It was resolved that both organisations and individuals should identify articles of interest, and that the editor corresponds directly with the author when requesting that the author adapt the article to meet his/her rationale/purpose.
- In the area of special issues or thematic editions, there is an identified need for synthesis articles to be orientated toward to international community, to be issue oriented, and
to summarise what we know, the contexts and to target future action. While the journal could commission papers, most will still need to adhere to editorial review policy. This appears to be possible within existing organisational structures and does not infringe upon issues of editorial board responsibility, compared to a proposal which would require periodic reviews of literature, format/section requirements.

- Possible first themes and sample ideas include (1) international dialogue on the science curriculum – goals, purposes, curriculum orientation; aims/forms of use of experimental work, purposes, new technologies, evaluation/assessment; link to teaching/learning literature; relationship among disciplines/ways to establish interdisciplinary bridges; (2) issues of teacher education; (3) teacher oriented synthesises of research on specialised topics within science education that could enhance the teaching and learning of science.

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First International Conference on Geoscience Education and Training

A conference report

The UK’s first ever international conference on geoscience education and training was held at the University of Southampton from 20-24th April, and turned out to be a resounding success. Some 250 participants from 50 different countries worldwide attended – everywhere from Croatia to Vietnam, Lithuania to Columbia, Senegal to The Phillipines.

But equal to the spectrum of nationalities represented was the range of questions addressed:

- How should we teach geoscience at school and where is it provided for in different national curricula?
- How are we coping with the challenges that face higher education today and are we keeping pace with the dramatic changes in educational technology?
- Why do so many girls choose to study geology at university and how can we redress the pyramidal decline of women geoscientists moving up the career ladder?
- Does the quality of geoscience degrees worldwide match the needs of society and how do we further meet the training needs of business and industry?
- Is geoscience education responding adequately to the very real and live issues of global environment and development?
- How do we as geoscientists translate our knowledge and concerns to the language of politicians and planners?
- What are the ways in which we can raise the general profile of geology in our society? What is the role for geotourism, ecotourism, etc?

"At first we thought that this was far too much for a single event" said the Conference Convenor, Dr Dorrrik Stow of the University's Geology Department, "but we divided the issues into five separate themes, each with its own set of workshop sessions, and ran with it. The information exchanged, ideas generated and enthusiasm promoted was quite astounding."

Several keynote speakers were invited to address the plenary sessions. Sir Ronald Oxburgh, Science Adviser to the UK Ministry of Defence, gave a lively and graphic illustration of how geology has changed from a sterile to a sexy subject. Jerry Leggett, Scientific Director of Greenpeace, spoke passionately of our overriding responsibility to the environment, to document the long-term changes in global climate and to warn our politicians the consequences of our actions. Diane Warwick of The Westminster Foundation for Democracy emphasised the importance of a stable social, economic and political foundation as the template on which to build any meaningful educational service.

The ideas flowed! A geo-walk around the city demonstrated how effectively building stones can be used to teach geology. Good practice in field excursions was further examined during the wet evening in a local gravel pit and through a sunny day on some classical geological sections along the south coast. Workshop sessions were devoted to the use of self-instructional computer programs for teaching, the making of geo-movies, the greening of geoscience, adult education and much more.

An evening workshop on Women in Geoscience was brimming with anecdotes and statistics. Jane Plant, Assistant Director of the British Geological Survey, profiled this largest employer of geologists in the UK, clearly illustrating the slow change towards equality between the sexes. Rosemary Enie recounted the struggles of being the only girl geology student in her class in Nigeria, whereas Zac Amante-Roberts portrayed the higher profile of women geoscientists in The Phillipines.

At the close, the convenor said "Geosciences play a vital role in underpinning the social and industrial infrastructure of nations, and the training of geologists is therefore crucially important for the future. We had hoped that this meeting would provide a valuable forum for the international exchange of ideas, methods and data, and that it would stimulate a continuing dialogue between participants. On both counts we are delighted with the outcome."

The conference was organised by AGID and COGEOED (IUGS) in association with ICSU, the Earth Science Teachers Association (UK), The Geological Society, The Geographical Association, The British Geological Survey, the Geology Department of Southampton University, as well as ICASE.

For further information, write to Dr Dorrrik Stow, Department of Geology, University of Southampton, Southampton S09 5NH, UK.
Science, Technology and Communication: Utilisation depends on access

by Mitch O'Toole

This paper considers the relationship between science and technology and explores the role of communication in student access to either. Some indications of communicative difficulty are touched upon and the issue of teacher expectations is raised. The author proposes that science teachers take an active role in helping students to meet those language expectations which are often implicit in science curricula.

Science and technology are not necessarily a 'horn of plenty' from which national development will flow. Science involves a search for more powerful explanations while technology involves the refinement of 'knowhow' (Cross and Price 1992 p27). The relationship between the two is more complex than it may sometimes seem. Optimal development involves repeated interaction between both scientific and technological workers. Inappropriate technology will divert, if not waste, both finances and energy as surely in Hamburg (Germany) as it will in Hermannsburg (central Australia). Choices between technologies rest on explanations of their uses and functions as well as on knowledge of how to use them. Unthinking transfer of technology from one context to another can cause a host of unintended effects, many of which undercut the very reasons for which the technology was transferred.

A fundamental example

Remote Aboriginal communities in central Australia exist in very arid environments. The people do not move around as much as did their grandparents. So the disposal of human waste becomes very important to the health of the community. Traditional Australian pit-style bush latrines are smelly and unhygienic. They also support large numbers of bush flies, and these are a major cause of eye disease in remote communities. One response to this has been the provision of urban type ablation blocks with toilets attached. These require considerable water and some expertise if they break down. Urban style facilities tend to be used until they stop working and are then ignored or destroyed. The technology is not understood, and is only valued so long as it is useful. When it ceases to work, the community leaders see no reason to continue caring for it. A concrete ablation block squatting in 40 degree Celsius heat is only a smelly inefficient oven when the water stops flowing!

The Centre for Appropriate Technology (1990) developed a low maintenance alternative in 1982 (see Figure 1). The Ventilated Improved Pit (VIP) latrine is a safe, hygienic and comfortable place to sit which has outlasted more sophisticated systems in many remote communities. It is still very much in demand and the VIP latrines often remain in use even after flush toilets can be maintained by the community. The contrast between appropriate and inappropriate technology is fairly clear. Appropriate technology persists while inappropriate technology falls into disuse. In this case the appropriate alternative involved the application of some fairly basic science. The VIP latrine depends on understanding the behaviour of bush flies (they do not like dark places), heat absorption (a dark pipe will get hot), heat flow (heated air will rise) and the interaction between the three. The vent pipe produces a draught which draws the smelly air out of the pit, keeping the latrine in good odour and the flies out.

A balance between knowing how to do something and having enough understanding to decide whether the action is wise is very important for both local and national development. It is an essential part of literacy in science and technology. Science contributes that understanding.

The language of science

However, science is a communal activity. It is carried out by communities of scholars who are united by a common interest in the features of the material world around them and grouped according to the parts of that world in which they are interested. One of the marks of the scientific community is the specialist style of language which it has developed for internal communication. The scientific style is a characteristic mix of features drawn from the standard dialect of English. It is much more than merely a matter of jargon. The details of the scientific style have been investigated by many workers including Widdowson (1974), Evans (1974), Gardner (1974, 1977, 1980), Lynch et al (1979), Taylor (1979), Triamble (1985), and Veel (1992). Halliday (1990) indicates that the processes which led to the development of this style may not be restricted to the English language. Scientific registers seem to be emerging in other
languages as well.

Consequent problems for learners

Over the past decade, more and more science teachers have become aware of the difficulties which the scientific style can cause for secondary students. Vecl (1992) is part of an entire edition of the Australian Science Teachers Journal devoted to language and science. Student language difficulties have been most obvious to teachers working in richly multilingual contexts, but they are by no means restricted to such contexts. Gardner's work on non-technical words shows remarkable consistency, whether the students are in Papua New Guinea, Australia, the Philippines or the United Kingdom. There is also evidence of a similar consistency in the difficulty caused by features of the style at other levels (O'Toole 1985).

Many students are having some difficulty with the language through which secondary science is communicated.

These difficulties are being documented in reports on the final school exams in New South Wales, Australia. The examiners who compile these reports are science teachers and academics. They are neither language trained nor often able to clearly articulate their language expectations. However, they are able to recognise text which does not meet those expectations. They drew attention to student difficulty with technical words (such as 'geomorphology'), non-technical words (such as 'describe', 'name' and 'code'), sentence structure, expression and spelling. Some of the problems which the examiners isolated are well known. Students are notorious for not reading questions and then answering only part of what is asked. However some of the comments refer to specific communication difficulties, and there is sometimes a very fine distinction between a communication difficulty and a problem in conceptual grasp.

When students favour Lamarckian explanations of biological adaptation, it can be very difficult to disentangle conceptual confusion from imprecise expression. However, the very difficulty of separating conceptual and communicative issues makes student control of the conventions of the expected style all the more important. The recent examiners' reports indicate that there is a clear problem with communication within science for the senior school candidate group at large. The problems are not restricted to a small group of students for whom separate remediation may be appropriate. It is also unlikely that the phenomenon is restricted to Australia. If these problems exist among students who both choose science and complete their secondary education, it is little wonder that there are difficulties with scientific literacy in the general population.

Teacher expectations

Science teachers share a fairly broad constellation of expectations regarding students. They expect students to be able to understand when instructions or explanations are given. Teachers expect students to be able to extract meaning from text. They expect students to be able to demonstrate their understanding by answering questions or giving explanations. Teachers expect students to be able to write practical reports, notes, summaries and answers to examination questions. They expect students to understand instructions which deal with the particular processes and concepts of science.

It may be that some of the things teachers expect are unreasonable. It is true that a lot of needless verbiage could be cut out of science. Science text should not require 'the ability to comprehend inordinately circumlocuous prose all set about with fractured syntax' (Macinnis 1979 p5). However, there are some things which teachers will still want students to be able to do. Syllabus documents form expectations regarding students' communicating by reading, writing, speaking, listening, graphing, tabulating and so on. Teachers will continue to expect students to access stored knowledge to solve problems and this access is gained by extracting, organising, interpreting and evaluating information. Public statements by scientists, or about science, are often made using the specialist language style of science. Students need to be able to understand these statements before they can meaningfully evaluate them. Such evaluation is a necessary part of any notion of scientific literacy.

As science teachers, we need to be conscious of our language expectations because we do have reasonable expectations about what our students should be able to do in science. If our students do not meet these expectations then we should help them. If we want our students to function within the scientific style, then we need to actively teach it. Many students are not able to absorb the scientific style by intellectual osmosis. Lack of control of the style will greatly impede their access to the products of the scientific community.

Figure 1 The C.A.T. Ventilated Improved Pit Latrine

![Diagram of C.A.T. Ventilated Improved Pit Latrine]

22
We want our students to gain this access, so that they can use those products to improve their lives. The language through which that community interacts is a barrier to our students gaining such access and their attempts at that language can be a barrier to students demonstrating their degree of access in formal assessment tasks. If we expect them to write clear, concise and accurate practical reports, then we need to spend time teaching the conventions which define that particular format. If we expect them to describe complex processes and explain how they come about, then we need to help them to write paragraphs. No one else is going to teach our specialist style for us. We need to teach the things we expect our students to be able to do.

**Little use without access**

We want our students to have access to the intellectual products of the scientific community so that they can make proper use of the technological products which are proliferating so widely. This desire does not seem to be realised. Many of our students are not acquiring the concepts and skills which are the focus of much of our activity. This has wide social implications as schools are potentially the most efficient, if not always the most successful, agent for disseminating knowledge through the community. Once students leave school, they are no longer nearly so available, and attempts to help them come to clearly understand and wisely use are much more difficult.

Science is communicated through a particular style of language, and if students do not have some degree of control over this style, their access to the products of the communities which use it will be necessarily restricted. People who teach science, prepare science resources and write science textbooks all use versions of scientific English. Science teachers often expect students to operate within the style. Students need to be able to read material written in versions of the scientific style if they are to acquire the information contained in that material. If operation within the scientific style is seen as a reasonable expectation on the part of science teachers, then they need to be prepared to teach the requirements of that style directly. That is not as large a task as it sounds, as there is a variety of published material which they can use to help them do this. Supplementary language exercises (O'Toole 1992) can be selected or prepared to isolate and expose the features of the scientific style which cause problems for students. These can

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**Sixth ICASE General Assembly**

UNESCO Headquarters, Paris, July 1993

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*Photo (above): After the ICASE General Assembly, some of the delegates gathered outside of UNESCO Headquarters for this photo. From Left to Right: Prof Peter Okebukola (Lagos State University, Nigeria), Prof Samuel Bajah (Commonwealth Secretariat, UK), Brenton Honeyman (President ICASE, Australia), Rose Agholor (Nigeria), Bob Lepischak (Past-President ICASE, Canada), Prof U M O Iwobi (President STAN, Nigeria), Isaiah O Ikeobi (African Regional Representative, ICASE, Nigeria).*

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be sequenced into conceptually coherent sets which form a more active alternative to the more usual practice of note copying. Language development tasks can be used to realise the positive potential of group based practical work (Freer and O’Toole 1990).

There will be little wise use of technology if people do not have access to the tools for understanding provided by the scientific community. However, science teachers can make a positive contribution by directly teaching the style through which scientists communicate. Science teachers use a version of the style themselves and often expect students to operate within it. Therefore, directly teaching the style which forms part of their own expectations will certainly improve the performance of students for whom they are responsible.

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**About the author**

Mitch O’Toole has been involved at the interface between science and language for the past decade. He is currently training science teachers at the University of New South Wales, Australia. This article is a modification of a UNESCO Project 2000+ resource paper. Mitch O’Toole can be contacted at the St George Campus, The University of New South Wales, PO Box 88, Oatley NSW 2223, Australia.

*Photo (above):* The winning Japanese team and their solar-powered vehicle which broke all records in the 1993 World Solar Challenge, a marathon race between Darwin in the north of Australia and Adelaide in the south of Australia, a distance of 3200 km. The vehicle, named Honda Dream, reached speeds in excess of 100 km/h! The winning team and their vehicle attended the smaller scale event known as the International Model Solar Car Challenge held in Adelaide in November 1993. Refer to the section Science Technology Society in this issue which shares the highlight of this student enterprise event.
Professional Development for Science Teachers: A School Based Approach

by John Loughran

Introduction

In the latter part of 1990 and for the first three months of 1991, 75 science teachers from varying schools across Australia were interviewed as part of the Science Education Professional Development Project (SEPD). This was a Department of Employment, Education and Training (DEET) funded Project of National Significance and its brief was to develop a strategy to enhance the professional development of science teachers.

The SEPD project aimed to provide data (Loughran & Ingvarson 1991a, Ingvarson et al 1992) that would eventually help teachers. Such data is helpful in better validating science teachers' views of professional development and thus strengthening the need for enhancing science teachers' professional development.

This paper attempts to outline one recent attempt at responding to some of these findings.

Factors affecting teachers' views of professional development

During the interviews, a number of issues were raised by science teachers as they discussed their experiences of professional development activities. There was no disagreement with the notion that if a science teacher is to develop and grow in a career, teaching and professional development should be closely linked. But for varying reasons, science teachers perceive that this is not as common as it should be.

1. Low level expectations for the value and usefulness of professional development

Teachers' expectations of professional development were affected by their previous experiences. They had come to expect little from professional development activities because they had received little from them in the past. For many their expectations were often related to the level of boredom they had experienced. The activities they attended did not seem to have a positive impact on their professional development and tended to encourage them to be wary of their choices in the future. Consequently, valuing the professional development activities currently offered was not common.

The main point in many of these interviews was the frustration from not getting enough in-service education focused on science content, and the teaching of science content — what Shulman (1987) calls 'pedagogical content knowledge'.

As many formal professional development activities for science teachers do not appear to address satisfactorily their pedagogical needs, they tend to look elsewhere for advice and ideas to enhance their pedagogical content knowledge. This may be one reason why science teachers tend to attach more importance to talking informally with colleagues than to externally organised and run professional development activities. They continually spoke of 'learning from colleagues' and 'sharing ideas' as major influences on their professional development.

2. Low level requirements for their own professional development needs

The striking feature of teachers' responses to questions about their professional development needs was the modesty of their claims. By any objective measure, or in comparison with other occupations, science teachers have limited opportunities to keep up with their field (Loughran & Ingvarson 1991b). But, an extra half-day or so for a course, a chance to visit another school or a factory — these were the limits of most teachers' claims. Their responses were couched in global terms related to such things as resources, equipment (amount and use of), content, 'catchy' new experiments, teaching strategies, technology and, in Victoria, the VCE (Victorian Certificate of Education).

It seems as though science teachers were not used to being consulted about their professional development needs. When speaking with science teachers, it was readily apparent that if professional development incorporated a process of determining needs then the outcomes would be much more positive.

3. A lack of participation in professional development activities

Of all the science teachers interviewed, 77% had attended no more that one day of professional development in science in the previous two years. Only 4% had attended more than three days of professional development in science during the same time period.

It is difficult to imagine how it is possible to stay in touch with one's area of science with so little time for professional development. It also seems quite unfair to expect science teachers to be up to date with recent
innovations with so little support. It seems an unreasonable expectation that science teachers keep up to date with their specialist field when they are not given a real opportunity to be involved in professional development activities.

4. A lack of time available to attend professional development activities

Many science teachers’ reason for limited involvement in professional development was a lack of time. Science teachers continuously spoke of an inability to ‘fit’ professional development into their schedule. For many teachers professional development was not a major school priority, or something their school could afford. This meant time to attend professional development became increasingly difficult for individuals. This is not to suggest that science teachers used ‘time’ as an excuse for non-attendance. Most of the science professional development activities that teachers attended were in their own time after school and on weekends. This was due to the limited opportunity they had to attend during school hours and partly because the organisers were teachers themselves and could not be released to offer the programs during the day.

5. Feelings of guilt associated with ‘abandoning’ classes and ‘forcing’ colleagues to cover their absence

A disincentive for involvement in professional development activities was the feeling of guilt that many teachers experienced as a result of being away from school and their classes. It was difficult for science teachers to reconcile the benefits of professional development with the consequences of the absence from the classroom and from school generally. Another disincentive to attend in-services is the extra work their absence creates for them. When teachers are working away from school, they have to prepare appropriate work plans for replacement/substitute teachers to follow. They also feel that the students are missing out if they are not there to teach their own class.

Minimal relationship between professional development activities and shifts in their pedagogy

Unfortunately, it was not common that science teachers noted much, if any, change in their teaching as a result of professional development activities. Significant changes in attitude and skill take considerable time. Programs that lead to changes in pedagogy are time consuming, expensive and require ongoing commitment. But the opportunities for such involvement have been limited.

A response to the SEPD findings: school-based professional development

It is interesting that in Britain similar concerns about science teachers’ professional development are also emerging. Nott, Watts & Oakes (1992) describe how a recent survey of science teachers illustrates how uninformed science teachers are about the opportunities of in-service education. Also, how little control they have over their own professional development. They highlight the need for career development to be matched by appropriate professional development and that this be a right and a duty, not “as it is at present—snatched opportunities”.

One way of responding to these findings is currently being explored at a large independent co-educational school in Melbourne. The Science Coordinator has organised to bring professional development to the teachers. More importantly, the nature of the professional development varies with the teachers’ needs. The program is organised so that each member of the science faculty is given the chance to work with a science educator from a nearby university. However, the collaboration between the two revolves around the school setting, not the university. In this case, the science educator must be able to attend the school when the teachers are free, rather than the teachers having to fit in with the university’s timetable or program. This effectively gives the teachers control of when they will be involved in professional development, considerably easing the constraints on their time. The issue of time is also minimised as the activities occur at the school, removing the burden of travel often associated with getting to professional development activities.

The success of the collaboration hinges on the relationship each individual teacher has with the science educator. A major requirement of good professional development is trust. Because this project is for a minimum of twelve months, interpersonal trust between participants is developed over time enhancing learning opportunities for all those involved.

Program organisation is dynamic rather than static. Teachers ‘contract’ with the science educator to discuss their issues/concerns and to decide how they might like to tackle them. A variety of approaches has been developed in the first six months of this project. One approach has been for the teacher to invite the science educator into his/her class to observe ‘normal’ classroom practice. As was pointed out by one of the science teachers, “I haven’t had anyone actually watch me teach since I did my DipEd.” An important aspect to this approach is that the teacher is using a third person to act as an observer or recorder of the classroom events. This means that reflection on activities may be enhanced as the observer can concentrate on the events without having to also be responsible for directing them. Debriefing focuses on students’ approaches to learning, giving the teacher the chance to construct appropriate pedagogical responses for future lessons.

Debriefing is not an expert’s critique of a teacher’s lesson. It is (and must be) a genuine sharing of ideas and construction of responses to the complexities of learning in the particular class being observed.

Variations of this activity have included the teacher seeking help with particular teaching strategies. In this case, different ways of teaching content may be tried (eg Jig-saw group work method, interpretive discussions, Prediction-observation-explanation techniques) so that the teacher’s understanding of these skills may be increased; the focus always being the impact of the strategy on student learning. Another is the teacher directing the observer to note how particular teaching skills (eg questioning, wait-time, encouraging student responses) are performed. This leads to debriefing that focuses on a teacher’s skills, but is not personally
threatening as it is at the individual's instigation so tends to be a very positive learning experience.

Because the project has no formal organisational structure which must be adhered to, a great degree of flexibility in the mode of professional development activities is developing. One of the most interesting has been by a small group of chemistry teachers. They have organised to meet at the same time each week and to discuss how they have taught particular content and how it influenced their students' understanding. Through this approach, they are able to 'experiment' with different teaching strategies in the same content area all at the same time. Therefore, their discussions allow them to better compare and contrast approaches and to seriously reflect on both the advantages and disadvantages from their own perspective. That way, no-one is 'forced' to take pedagogical risks that they are uncomfortable with, but are able to 'ease' themselves into areas which they may once have lacked the confidence to pursue. Also it allows them to have a more coordinated approach to curriculum development and to use the science educator in different ways at different times. This varies from a resource for ideas on teaching strategies, to a researcher, or additional classroom teacher depending on the need at the time or as the teachers see fit.

Implicit in this project is the need for the professional development to be responsive to the teachers' needs. After six months of 'experimenting' it appears as though real inroads are starting to be made. The teachers are dictating the direction of the project and are apparently bridging the theory-practice gap as they seek to better understand their own teaching and their students' learning. This has been possible because barriers to professional development for science teachers noted in the SEPD project are being addressed. Their expectations of professional development are raised because they are able to set the agenda, therefore placing more value on the process and the outcomes. Their requirements of professional development increase as their individual needs are able to be addressed. They also get more from the activities because they put more into them. Their participation rates have increased because access is easier and does not require extended absence from the classroom, resulting in time being better used so that professional development is moulded around the classroom instead of out of the classroom. Finally, there is a positive relationship between professional development and pedagogy because student learning has become the focus. Therefore, shifts in pedagogy are inevitable if teachers genuinely wish to enhance their students' learning.

**Conclusion**

There has been a considerable advance over the past fifteen years or so in what we know about effective models of professional development. This research is well summarised in a number of publications (eg Commonwealth Schools Commission 1988). Effective professional development is best if it is long-term and carefully planned with follow-up support. There are no short cuts to change in teaching methods but science teachers should at least be in a position that affords them a reasonable opportunity to be involved in professional development. It is important that the professional development offered to science teachers is appropriate and relevant as well as being presented in a meaningful way.

The Commonwealth Schools Commission (1988) report 'Teachers Learning' defines the purpose of professional development as improving the 'educational enterprise' through improved teaching quality and better student outcomes. Professional development is a useful medium for focusing teachers' attention on research and practical classroom activities designed to improve the quality of science teaching and learning. It should be an integral component of work, not an occasional additive. The school-based program briefly described in this paper is one attempt at doing this.

A more extensive research report will be written at the completion of the first twelve months of this project. It will be documented from the teachers' perspective so that learnings may be built on in the future in a similar way to the PEEL project (Baird & Mitchell 1986, Baird & Northfield 1992). Through this mechanism of reporting research findings, it is hoped that teachers' knowledge might be better documented and become more accessible to other teachers. That way professional development might be better able to help science teachers bridge the theory-practice gap.

**References**


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**About the author**

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Exsciter Paks
A classroom resource playing a role in the professional development of primary teachers

by Brenton Honeyman

At first sight, it looks like a spelling mistake! But 'Exsciter Pak' is an acronym for 'Exciting Science & Technology Resource Pak'. A number of 'paks' have now been developed by Questacon – The National Science and Technology Centre in Canberra, Australia. Titles currently available include Bubbles, Environment, Music, Balloons, Candles and Energy. Each pak includes an activity booklet which includes core activities, explanations of science principles, links to everyday situations, and suggestions for further exploration. The paks contain the necessary materials for each of the core activities. Materials are usually readily available from supermarkets, etc.

The paks are being used in a variety of contexts. They are popular purchases by families visiting Questacon, a large interactive hands-on science centre with a national charter to facilitate the understanding of science and technology by Australians of all ages. As such, the paks are helping children and adults in family settings to understand simple science concepts and how they relate to their everyday lives.

The paks have also been used in School of the Air programs. This involves sending paks in advance to children living in isolated regions of Australia, and their teacher communicating with them by two-way radio. The teacher 'coaches' the children as they learn through the many open-ended hands-on activities.

But, by far the biggest demand for Exsciter Paks has been by classroom teachers in primary schools across Australia — and one of the reasons for their popularity is that Questacon's workshop program for primary teachers has been using the paks to illustrate how they can bridge the gap that is so often missing in other primary science resources.

The professional development program entitled Hands-on Minds-on: Strategies for Primary Science and Technology consists of a series of workshop sessions during which primary teachers experience a variety of strategies which focus on the quality of interactions between teacher and students. The very first activity that participants experience involves them in a fun exercise which, at first sight, seems to be a great idea for a science activity. But participants come to realise that it is not enough to simply do activities, no matter how much fun or excitement they may generate. It is important for primary teachers to provide hands-on activities so that they are minds-on as well.

The workshop program goes on to emphasise the importance of (1)
providing a context which is real for children; (2) providing opportunities for open-ended investigating and exploring; and (3) helping children to develop an understanding of the science underlying activities. The workshop program explores these points via strategies based on a constructivist model of learning, while building up teachers' understanding of -- and, just as importantly, confidence in -- a number of science topic areas. Exciter Paks help greatly in this because:

(1) they are structured so that teachers can use strategies to monitor children's learning growth as children explore the science activities;

(2) they provide simple explanations and storylines of the science principles involved; and

(3) they avoid the 'recipe' approach to doing science by encouraging children to carry out further investigations; solve problems; design, make and appraise a device or procedure; etc.

As such, they are proving to be a useful resource for schools implementing a primary science curriculum. Because they contain the materials required to do the activities, busy teachers are more likely to try the activities and therefore become confident in engaging their students in the activities.

Australia, as are many other countries, is engaged in a period of national curriculum development in primary science. The Centre's professional development program together with its Exciter Paks are providing primary teachers with support to tackle what is for many of them a formidable challenge because of their relative unfamiliarity with science.

Early in 1994, Exciter Paks will be available in a new 'export' pak form, and indications are that they will provide a useful resource for primary teachers in other countries. Some early planning has commenced to work with local teachers in other countries to adapt and translate the paks so that they relate to the contexts of children in those countries.

Each pak focuses on a theme which encompassing several science concepts:

**Bubbles**

Float a paperclip, make a soap powered boat, create bubbles of different shapes and explore the science of surface tension. Learn about animals that walk on water, how detergents clean away dirt, and lots more!

**Environment**

Explore the science of our environment -- investigate air pollution, make your own recycled paper and study the effects of sewage. Learn about soil erosion, acid rain, biodegradable materials, the effect of salt on the growth of plants, and more!

**Balloons**

Discover how rockets work, make a balloon powered boat and stick a pin into a balloon without bursting it! Investigate how hovercraft glide and satellites orbit the earth. Learn about air pressure, static electricity and more!

**Candles**

Explore the science of candles, create shadows of candle flames and make candles you can eat! Investigate the fascinating world of heat, design a hot air spinner and interpret invisible messages using a candle. Learn how water can be boiled in a paper cup, and much more!

**Other titles**

Other pak titles include: *Music*, which explores the science of sound and music; and *Energy*, which focuses on sources of energy and energy changes.

New titles in production for release during 1994 include: *Circuits*, which features basic electric circuit principles and problem solving; and *Magnets*, which explores the behaviour and applications of magnets.

**For further information**

For further information about either the professional development program for primary teachers or Exciter Paks, contact:

**Brenton Honeyman, Manager**
Education & School Programs
Questacon -- The National Science & Technology Centre
King Edward Terrace
Canberra ACT 2600, Australia
Fax +61 6 273 4346

**AVAILABLE SOON!**

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for teachers of

**Primary Science and Technology**

*Edited by*

**Yunus Sola & Sue Dale Tunnicliffe**

**AN ICASE PUBLICATION**

*Enquiries: Dennis Chisman, Honorary Treasurer*
Knapp Hill, South Harting
Petersfield GU31 5LR, UK

29
Stepping into Science
An ICASE Primary/Elementary Science Project

AIMS
Stepping into Science is an ICASE project which aims to:

• Establish an international network for teachers to share ideas on the teaching of primary/elementary science and technology.
• Provide activities and support for teachers, thereby encouraging them to include more science in the primary/elementary curriculum.
• Promote the value of science experiences for young children throughout the world.
• Facilitate professional development opportunities for teachers by including sessions on primary science and technology in regional and international conferences.

ACTIVITIES
The Stepping into Science Team is actively involved in a number of projects and activities including:

• Publishing STEPS, the Stepping into Science Project Newsletter. This newsletter contains ideas for class activities at various levels in primary/elementary schools, activities for children to do at home, comments by network members on issues, examples of children’s work, lists of helpful resources and contacts.
• Contributing articles and ideas for the Primary Science Section in Science Education International, the ICASE quarterly journal.
• Compiling ideas and activities for inclusion in a series of sourcebooks on the teaching of primary/elementary science and technology.
• Coordinating a scheme to encourage children to participate in science and technology activities. Certificates of Participation have been produced, and are available for schools to use in rewarding students as they complete a number of activities. Certificates are colour coded in seven different colours, so that they can be used to acknowledge progress in science from early to advanced levels within primary/elementary schools. ICASE is grateful to BP (Oman) for sponsoring this scheme.
• Organising Stepping into Science workshops and displays of children’s work at national, regional and international conferences.

FOR MORE INFORMATION
Contact the ICASE Primary Science Officer:
Sue Dale Tunnicliffe
ICASE Primary Science Officer
Stepping into Science Project
18 Octavia, Bracknell
Berkshire RG12 7VZ
United Kingdom
1993 International Model Solar Car Challenge
Adelaide, South Australia

On Sunday, November 14th, students from around Australia and New Zealand converged on Adelaide for the first International Model Solar Car Challenge—a unique event to design and race one-tenth scale cars powered only by solar energy. 24 teams brought their innovative vehicles to Prince Alfred College to compete on the 100 metre track. The teams, with members ranging in age from 12 to 18, had qualified for the event in state-based events.

The Chairman of the Organising Committee, Jeff McIntyre reported that the event had been a unique opportunity for students, teachers and parents to become involved in an event that links scientific, environmental and technical themes. "Students understand predictions of global warming and other environmental problems and realise that we must change the way we do things if we are to preserve our environment" commented Jeff McIntyre.

"As Thomas Edison once said, the best way to predict the future is to invent it" he added.

The first section of the event involved a time trial under artificial lights along a 15 metre single lane track. These time trials were used to provide the seedings for the outdoor event.

The outdoor event realised very fast times due to optimal sunlight conditions on a warm, cloudless day. Students raced their vehicles in pairs on a dual lane 100 metre S-shaped track and, considering that the track was not perfectly flat, the 20 km/h average speeds achieved by the faster cars were impressive accomplishments.

Cars progressed through early round-robin competitions through to semi-final and final rounds.

Winning teams were as follows:
- 1st place: Eastern Hills Senior High School Team 2, Western Australia
- 2nd place: Lynall Hall Community School, Victoria
- 3rd place: Eastern Hills Senior High School Team 1, Western Australia
- 4th place: Shalom Catholic College, Queensland

The next International Model Solar Car Challenge will be held in 1996 to coincide with the finish of the 1996 World Solar Challenge, which is a 3200 km race between full size solar powered vehicles from Darwin to Adelaide. The 1993 World Solar Challenge was the biggest event ever, attracting 46 entries from many nations including the USA, Canada, Germany, New Zealand, Japan, Switzerland and Australia.

One of the special features of the IMSCC event in November was the opportunity to see the vehicles and meet the teams which won top placings in the 1993 World Solar Challenge. The winning vehicle, the Honda Dream had just won the long race from Darwin to Adelaide in record time, travelling at average speeds between 90 and 95 km/h.

Utilising a teaching resource kit developed in Australia by Keymac Educational which includes an 8 watt array of Australian-made solar cells, students have used the event to explore ways to apply their increased knowledge of solar energy to improving transportation options of the future.

The 1993 International Model Solar Car Challenge was based on a challenge first held in Victoria and now held throughout Australia. In those events, students have advanced the design of model vehicles and, in the process, developed important teamwork and engineering skills.

It is hoped that IMSCC 1996 will attract teams from several countries. There is already a growing interest in Japan and the USA in joining this event. Model solar cars can be designed and developed on a small budget and therefore offers schools a viable way to participate in a program which has the

Photo: Brenton Honeyman (left) presenting the IMSCC Trophy to the winning team members of Eastern Hills Senior High School, Western Australia.
potential to link students of science, technology, environmental studies and enterprise programs in a team effort to design state-of-the-art model vehicles powered only by solar energy.

The 1993 IMSCC was generously supported by a number of sponsors including the Department of the Environment, Sport and Territories; Electricity Trust of South Australia; Energy Credit Union of Western Australia; General Motors Holden Automotive; Questacon – The National Science and Technology Centre; the Australian and New Zealand Solar Energy Society and the Society of Automotive Engineers.

For information about the 1993 event, or how to enter future national and international events, please contact:

Mark Needham, Project Coordinator
22 Harding Street
Glengowrie SA 5044
Australia
Fax (International) +61-8-296-5912

Photo (left): As the starter gate is open, the solar panels of two model vehicles begin their work of converting solar energy into electrical energy. The performance of these cars will depend on combined factors such as vehicle weight, suspension system, capacity to negotiate a curved track, gearing and motor specifications.

Photo (right): Two contestants wait to catch their model vehicles as they approach the finish line after negotiating a 100 metre S-shaped dual lane track made of corflute with PVC channel which, in combination with the guide pin mechanisms of the model cars, keeps the vehicles in their lanes.
Bridging School and University

The Pre-Entry Science Course at the University of Botswana

Edited by Mike Cantrell, Wim Kouwenhoven, Thabo Mokoena, Gerard Thijs

The book provides a comprehensive account of the development of the Pre-Entry Science Course at the University of Botswana from its inception in 1977 until the present. The Vrije Universiteit in Amsterdam has assisted the University of Botswana in implementing the Pre-Entry Science Course. This cooperation was the start of a broader program of so-called 'basic science projects' of inter-university cooperation of the Vrije Universiteit in Amsterdam with other universities in the region of southern Africa.

The topics and issues presented in this volume will be of interest to educational planners and policy makers and institutes in developing countries.

The book is not intended to be a detailed history of the course, but rather an analysis of the current program and the various strategies and refinements which have proved effective in the fifteen years since it began. It is divided into four parts:

The first part sets the scene describing the educational background and how the course was started with donor assistance. The second part considers the current Pre-Entry Science Course after sixteen years of development. The third part looks at the impact of the course from various points of view. The fourth and last part examines trends in this and other bridging courses in the region.

The seven month long course is not an A-level crash course for aspiring scientists. Rather, it attempts to remedy gaps in students' knowledge and skills, particularly the practical skills which are often underdeveloped at school, and provides upgrading from an O-level base to meet the requirements of the existing BSc year 1 program.

Language and study skills training is linked to the sciences so that students are better able to learn and succeed in the tertiary environment.

Within the Southern African region there is increasing concern about better access to tertiary education for disadvantaged students and ways to improve their chances of survival after admittance. This book is one contribution to the debate on this complex issue.


For further information, write to:
Dr G D Thijs, Centre for Development Cooperation Services, Vrije Universiteit Amsterdam, De Boelelaan 1115, 1081 HV Amsterdam, The Netherlands

ICASE

The First 20 Years

1973-1993

A brief history

This new publication is a brief history of the International Council of Associations for Science Education.

It is not intended to be a comprehensive account, but rather an overview of the key happenings and milestones in the development of the organisation and the policies and strategies that have enabled it to reach its present position in the international community of science education.

It also looks forward to the future, especially to the turn of the century, and examines possible options for the continual development of ICASE as an umbrella organisation for science education associations and similar bodies.

Copies can be ordered from:

Dennis Chisman
Honorary Treasurer, ICASE
Knapp Hill, South Harting
Petersfield GU31 5LJ
UK

Australian Chemistry Resource Book

Vol 12, 1993

Edited by C L Fogliani

Available from:
C L Fogliani, Chairman
Australian National Chemistry Week
c/o School of Applied Sciences
Charles Sturt University - Mitchell
Bathurst NSW 2795, Australia
ICASE is keen to arrange regional or world events for the benefit of member associations. If your association or organisation is interested in hosting an international seminar, workshop or conference, contact the Executive Secretary or your Regional Representative. To gain ICASE endorsement, the meeting must be international in nature, open to member associations, and, while all sectors of the science education community should be encouraged to participate, must be relevant to classroom teachers.

1994

January
ASE Annual Meeting
Location: Birmingham, UK
Contact: Annual Meeting Secretary, ASE Headquarters, College Lane, Hatfield AL10 9AA, UK
This large international event is the annual meeting of the Association for Science Education and features a wide ranging program of sessions led by speakers from many parts of the world.

January 27-30
SAARMSE Second Annual Meeting
Location: University of Durban-Westville, South Africa
Contact: SAARMSE Secretariat, PO Box 17112, Congella 4013, South Africa
The meeting, open to anyone interested in research in science or mathematics education, is being organised by the Southern African Association for Research in Mathematics and Science Education (SAARMSE). There is no specific theme for the conference, but there will be a major thrust in the areas of policy research and action research. The meeting will consist of plenary lectures, symposia, workshops, poster sessions and presentations.

April 7-23
Sixth Edinburgh International Science Festival
Location: Edinburgh, Scotland
Contact: Marion-Jane Pate, Assistant Chief Executive, Edinburgh Science Festival Ltd, 1 Broughton Market, Edinburgh EH3 6NU, Scotland, UK
Following the success of the 1993 Festival which attracted over 200,000 people to 367 events, preparations for the 1994 Festival are now well in hand. Major themes include: (1) Being the right size; (2) Molecule of the day; (3) Science myths of out time. In addition, exhibitions, talks, debates, workshops (including Madlab, Computer Arcade, FUNdamental Physics, Science Dome), family events, performances, tours, and conferences will be featured in the program.

April 10-13
International Symposium: When Science Becomes Culture
Location: Montréal, Québec, Canada
Contact: Quand la science se fait culture, Université du Québec à Montréal, CP 8888, succursale A, Montréal, Québec, Canada H3C 3P8
Symposium themes include: (1) Realities of today’s scientific and technological culture – how far have we come? National reports on accomplishments; (2) Methods and practices of scientific and technological culture; (3) Practitioners of scientific and technological culture; (4) Sharing of knowledge and democratic accountability; (5) Taking up the challenge of sustainable economic development. The deadline for receiving full papers (conditions apply) for consideration by the scientific committee is 1st February 1994.

June
Schola Ludus: Science and the Public
Location: Bratislava, Slovak Republic
Contact: Schola Ludus, Faculty of Mathematics and Physics, Comenius University, Mlynská dolina F2, 2 15 Bratislava, Slovakia
This international conference will feature four themes: (1) Building up a hands-on science centre; (2) Supporting lifelong education; (3) Building up an open and consistent learning about the universe and life on Earth; (4) Finding the essence of real scientific, human, technical and environmental problems. The conference sessions will be conducted in English and Slovak/Czech.

July 4-8
CONASTA 43
Location: Launceston, Tasmania, Australia
Contact: Donna McWilliam, CONASTA 43, PO Box 1922, Launceston Tas 7250, Australia, Fax (003) 34 2598
The theme for the 43rd annual conference of the Australian Science Teachers Association (CONASTA 43) is ‘In from the cold’. The program brings contemporary developments and information to teachers within an atmosphere of support. Hear about new ideas and approaches in science and technology, keep abreast of latest developments, evaluate new resources, and meet teachers from all over Australia and beyond. Keynote addresses, workshops, displays, social events and a family program make Launceston an exciting place to be in July 94!

July 17-22
Fifth InterAmerican Conference on Physics Education
Location: Texas, USA
Contact: Robert Beck Clark, Texas A&M University,
College Station, Texas 77843-4242, USA, Fax +1-409-845-2590.
The theme of 'Building bridges for cooperation in physics education' will feature sessions in English and Spanish.

**July 27 - August 10**
**London International Youth Science Forum**
Location: London, UK
Contact: LIYSF, PO Box 159, London SW10 9QX, UK
The Science Forum is the principal annual meeting in Britain of young scientists. Over three hundred students attend from some fifty nations to make this an international event of major significance. The program features lectures, seminars and demonstrations from leading scientific names, and an extensive range of visits to university and industrial research establishments.

**August 8-12**
**13th International Conference on Chemical Education**
Location: San Juan, Puerto Rico
Contact: Ram S Lamba, Chairman 13th ICCE, Inter-American University of Puerto Rico, PO Box 191293, San Juan PR 00919-1293
This will be the first time that an ICCE meeting will have been held in the Caribbean Region. The objective of this conference is to bring together chemistry teachers from the pre-college and college levels to share ideas and learn from each other about innovations in the teaching and learning of chemistry. The theme is 'Chemistry: The Key to the Future'. The Conference will feature plenary lectures, symposia, lecture presentations, workshops, poster sessions and exhibitions. Scientists and science educators from around the world will report their work.

**August 24-31**
**7th International Symposium on World Trends in Science and Technology Education**
Location: De Koningshof, Veldhoven, The Netherlands
Contact: Secretariat 7th IOSTE symposium, PO Box 2041, 7500 CA Enschede, The Netherlands
Symposium presentations will be organised around at least three cross-curricular areas of interest: (1) science/technology related social issues including environment, health, peace, third world development, risk and safety; (2) further education and employment including career orientation, career preparation; (3) teaching methods include fieldwork, cross-curricular projects, computer simulations. Proposals for these and other topics are invited that report/reflect on research, practical experience or innovations relating to the main theme of 'Science and Technology Education in a Demanding Society'.

**August 28 - September 2**
**Scicon 94**
Location: Wellington, New Zealand
Contact: The Convenor, Scicon 94, PO Box 523.
(VCI), and organised by Hoechst. The program will be a most relevant follow-up to the recent Project 2000+ International Forum, since Education-Industry Partnerships are an important strategy for improving scientific literacy.

December 6-10
9th ICASE Asian Symposium
Location: Bangkok, Thailand
Contact: Dr Janchai Yingprayoon, IPST, 924 Sukhumvit Road, Bangkok 10110, Thailand, Fax +662 381 0750
ICASE Asian Symposia are always significant events in the Asian region, attracting delegates across the region and further afield. The theme of this symposium, organised by the Institute for the Promotion of Teaching Science and Technology (IPST) and The Science Society of Thailand, will be the use of computers in science education and the need for low cost, locally produced equipment.

1995

January
ASE Annual Meeting
Location: UK
Contact: Annual Meeting Secretary, ASE Headquarters, College Lane, Hatfield AL10 9AA, UK
This large international event is the annual meeting of the Association for Science Education and features a wide ranging program of sessions led by speakers from many parts of the world.

June 5-12
XVIII Pacific Science Congress
Location: International Convention Center, Beijing, China
Contact: Secretariat, c/o Institute of Atmospheric Physics, Chinese Academy of Sciences, PO Box 2718, Beijing 100080, PR China, Fax +86-1-2562458
The Pacific Science Association invites delegates to this Pacific Science Congress which focuses on the theme 'Population, Resources and Environment: Prospects and Initiatives. Scientific sections include Science Communication and Education. For those who are interested in receiving a First Circular, write to the contact address above.

July 26 - August 9
London International Youth Science Forum
Location: London, UK
Contact: LIYSF, PO Box 159, London SW10 9QX, UK
The Science Forum is the principal annual meeting in Britain of young scientists. Over three hundred students attend from some fifty nations to make this an international event of major significance. The program features lectures, seminars and demonstrations from leading scientific names, and an extensive range of visits to university and industrial research establishments.

August 25 - September 1
International Conference on Industry-Education Initiatives in Chemistry
Location: University of York, UK
Contact: Miranda Mapleton, Chemical Industry Education Centre, Department of Chemistry, University of York, York Y01 5DD, UK, Fax +44-904-432516
This international conference is co-sponsored by the International Union of Pure and Applied Chemistry (IUPAC) Committee on Teaching of Chemistry, and the Royal Society of Chemistry Education Division and Industrial Division.

September
CONASTA 44
Location: Brisbane, Australia
Contact: David Tulip, Convenor, CONASTA 44, Queensland University of Technology, Locked Bag No 2, Red Hill Qld 4059, Australia
The theme of the 44th annual conference of the Australian Science Teachers Association (CONASTA 44) will be 'The Science Teacher – An International Perspective'.

October 27 – November 1
Third Conference on History, Philosophy and Science Teaching
Location: University of Minnesota, Minneapolis, USA
Contact: Prof Fred Finley, Dept of Curriculum & Instruction, University of Minnesota, Minneapolis, MN 55455 0208, USA, Fax +1-612-624-8277.
The organisers are keen to encourage the production of units of work and lessons in science and mathematics which incorporate historical and philosophical themes.
Extending and Improving Education in Science
for All Children and Youth by Assisting
Member Association Throughout the World

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This journal provides a means for associations, institutions, centres, foundations, companies and individuals concerned with science education, to share perspectives, concerns, ideas, and information which will foster cooperative efforts to improve science education, and which will serve as a chronicle of the advancement of science education throughout the world.

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Lincoln, NE 68588-0355

**Dates for Receipt of Contributions**

<table>
<thead>
<tr>
<th>Issue</th>
<th>Closing Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>March</td>
<td>1 February</td>
</tr>
<tr>
<td>June</td>
<td>1 May</td>
</tr>
<tr>
<td>September</td>
<td>1 August</td>
</tr>
<tr>
<td>December</td>
<td>1 November</td>
</tr>
</tbody>
</table>

**ICASE News**

**Calendar**

**Feature Article**
I.A.S.C. Questionnaire Results

**Science Education Around the World**
Science Education in the Caribbean
STS Approach Within Science Education in Italy

**Research on Curriculum, Teaching and Learning**
Status of Women in University Science

**Teaching Materials & Strategies**
Teaching Science to Visually Impaired Students

**Science Teacher Education and Leadership**
Revitalizing Teacher Preparation in Science

**Assessment & Evaluation Trends**
A Celebration of Learning

**Non-formal and Informal Science Education**
The International Association of Science Clubs

**Resources**

**Profile**
The Passing of Florence Commissiong

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**PLEASE NOTE**
New Arrangements for sending articles and contributions for publication in Science Education International

**Send to:** Ronald J. Bonnstetter, Editor
Science Education International
Center for Curriculum and Instruction
211 Henzlik Hall
University of Nebraska
Lincoln, Nebraska 68588-0355, USA
Fax +1-402-472-8317
or directly to the Section Editor
Science Education International
Guidelines for Contributors
Updated: January 1994

Science Education International is the quarterly journal of the International Council of Associations for Science Education. ICASE was established in 1973 to extend and improve education in science by assisting member associations and institutions throughout the world to examine ways of promoting scientific and technological literacy for all and to provide a foundation for the professional development of our science and technology educators and leaders.

This Journal provides a means for associations, institutions, centres, foundations, companies and individuals concerned with science education, to share perspectives, concerns, ideas and information which will foster cooperative efforts to improve science and technology education throughout the world.

Section Contributions
When sending material to section editors, it is preferable that it reaches the section editor well in advance of the deadline for submission to allow for review and first round editing. Each section will offer a balance between an elementary and secondary focus, with half of the annual contributions being directed at each level.

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Language
Articles and other materials are accepted in English, French, and Spanish. French or Spanish articles should be sent to Ronald J. Bonnstetter, Editor, 211 Hennizk Hall, University of Nebraska, Lincoln, Nebraska 68588-0355, USA.

Feature Articles
Feature articles should be relevant to an international readership. Feature articles are normally solicited by invitation. Authors submitting feature articles for publication must restrict the length of article to 3000 words, including references. Authors are encouraged to include relevant diagrams, graphs, tables, and photos to illustrate their articles (see guidelines for supply of artwork and photos below). In addition, the author should supply a portrait photo and brief summary (50 words) of position and responsibilities, institution, etc.

Feature articles should be sent to Ronald J. Bonnstetter, Editor, 211 Hennizk Hall, University of Nebraska, Lincoln, Nebraska 68588-0355, USA. In the case of unsolicited articles, the Editor will advise each author whether the submitted article has been forwarded to a Section Editor or accepted as a Feature Article after an examination by referees.

ICASE News, Science Education Around the World, Resources, Calendar
Contributions for these sections should be brief and relevant to an international readership. It may be acceptable to submit excerpts from other publications and periodicals. For the sections ICASE News and Science Education Around the World the author may send a portrait photo and/or a fully captioned photo relevant to the event or project, together with brief details of author’s position, institution, etc. For the section Resources, a photo or line artwork pertaining to the resource may be sent with the contribution (see guidelines for the supply of artwork and photos below). These contributions should be sent to the journal editor.

Research on Curriculum, Teaching, and Learning
Articles about science education curriculum development and research should be relevant to an international readership. The number of articles published in this section will normally be limited to one per issue. The length of article should be limited to 1500 words, including references. Authors are encouraged to include relevant diagrams, graphs, tables, and photos to illustrate their articles (see guidelines for the supply of artwork and photos below). In addition, the author should supply a portrait photo and brief summary of position, institution, etc.

For more detail as to the nature of this section please review Focus Area Two of Project 2000+, Scientific and Technological Literacy for All found in the September, 1992 issue of SEI, Vol. 3, No. 3, page 5-6. Articles should be sent to the Section Editor, Jon Pedersen, 314 Graduate Ed., University of Arkansas, Fayetteville, Arkansas 72701 USA

Teaching Materials and Strategies
This section includes classroom ideas, student activity sheets, and articles which are relevant to an international readership. Each contribution should be short. Authors are encouraged to include relevant diagrams, graphs, tables, and photos to illustrate their articles (see guidelines for the supply of artwork and photos below). In addition, the author should supply a portrait photo, and brief summary of position, institution, etc.
For more detail as to the nature of this section please review Focus Area Three of Project 2000+, Scientific and Technological Literacy for All found in the September, 1992 issue of SEI, Vol. 3, No. 3, page 5-6. Teaching Materials contributions should be sent to the Section Editor, Sue Dale Tunnicleffe, 18 Octavia, Bracknell, Berkshire RG12 7YZ, UK

Science Teacher Education and Leadership
Articles about science teacher education (both pre-service and in-service) should be relevant to an international readership. The number of articles published in this section will normally be limited to one per issue. The length of article should be limited to 1500 words, including references. Authors are encouraged to include relevant diagrams, graphs, tables, and photos to illustrate their articles (see guidelines for the supply of artwork and photos below). In addition, the author should supply a portrait photo, and brief summary of position, institution, etc.

For more detail as to the nature of this section please review Focus Area Four of Project 2000+, Scientific and Technological Literacy for All found in the September, 1992 issue of SEI, Vol. 3, No. 3, page 5-6. Science teacher education articles should be sent to Section Editor, Ewve Van Den Berg, De Achikant 25, 1851 BV Heiloo, Netherlands.

Assessment and Evaluation Trends
Articles about assessment and evaluation should be relevant to an international readership. The number of articles published in this section will normally be limited to one per issue. The length of article should be limited to 1500 words, including references. Authors are encouraged to include relevant diagrams, graphs, tables, and photos to illustrate their articles (see guidelines for the supply of artwork and photos below). In addition, the author should supply a portrait photo and brief summary of position, institution, etc.

For more detail as to the nature of this section please review Focus Area Five of Project 2000+, Scientific and Technological Literacy for All found in the September, 1992 issue of SEI, Vol. 3, No. 3, page 5-6. Teaching Materials contributions should be sent to the Section Editor, Peter Spargo, School of Education, University of Cape Town, Randeboosh 7700, South Africa

Non-formal and Informal Science Education
Articles concerning non-formal and informal science development (such as out of school or public science experiences) should be relevant to an international readership. The number of articles published in this section will normally be limited to one per issue. The length of article should be limited to 1500 words, including references. Authors are encouraged to include relevant diagrams, graphs, tables, and photos to illustrate their articles (see guidelines for the supply of artwork and photos below). In addition, the author should supply a portrait photo and brief summary of position, institution, etc.

For more detail as to the nature of this section please review Focus Area Six of Project 2000+, Scientific and Technological Literacy for All found in the September, 1992 issue of SEI, Vol. 3, No. 3, page 5-6. Teaching Materials contributions should be sent to the Section Editor, Andrea Anderson, ASTC, 1025 Vermont Ave. N.W., Washington, DC 20005, USA.

Research in Brief
This section contains several brief, 300-400 word, summaries of published research related to the teaching and learning of science. The summaries may be drawn from journals world-wide but must be relevant to an international readership. The section may offer several summaries on varying topics or describe findings related to a central theme. Guest editors will be assigned. Contact the journal editor for additional information.

Profile
This occasional section features profiles of prominent science educators who have made a significant impact (e.g., ICASE Award Winners), and profiles of ICASE member association, institutions, centres, etc. Profiles should be limited to 400-600 words. A portrait photo must be sent with an individual profile; the logo of an organization and captioned photo of, for example, key officers, headquarters building, a project in action, delegates at a meeting, may be used to illustrate the profile of an organization.

Editorials
This occasional contributed or invited section represents an open forum to discuss science education concerns and perceptions. Editorials should be limited to 400-600 words. Profiles and editorials should be sent to the journal editor.

Supply of artwork, photos, etc.
Diagrams and graphs should be provided as finished line artwork, preferably bromide quality - note that the editor does not at this time have an artwork or graphics service. It is preferable that Tables be provided as finished artwork, however the editor has facilities to format tables. Photos should be supplied un-screened in original form. All illustration (diagrams, graphs, tables, photos) must be fully captioned. When there are a number of illustration, the author should endeavor to reduce the amount of text to accommodate the illustrations in the limited space available for any one article.
ICASE WELCOMES NEW MEMBERS

Centre for Educational Technology (CET) Israel

The Centre for Educational Technology (CET) is an independent non-profit organization dedicated to improving Israel's educational system. Its main task is to develop effective methods of instruction by generating and applying innovative educational ideas. CET programmes utilize modern technologies and original instructional materials.

Attuned to the needs and problems of Israel's educational and training systems, CET professionals offer educators and school principals comprehensive solutions which incorporate organizational improvement, in-service training, going professional guidance, innovative study methods and a variety of study materials (textbooks, workbooks, games and computer courseware) CET's projects and products serve a wide range of students in Israel, from pre-school and school pupils to soldiers and adults.

Established in 1971 and initially endowed by the Rothschild Foundation (Yad Hanadiv), CET finances its activities through distribution of its programmes and publications, and receives financial assistance from various foundations. The majority of CET's 250 member staff consists of professionals in the fields of education, psychology, computers, engineering, production and management.

CET programmes and multi-media materials (print, audio, video, computer) cover much of the basic school curriculum: mathematics, grammar and reading comprehension, literature, Bible, English, geography, and the sciences.

CET has also developed a few computer programmes for teaching scientific subjects at elementary and middle school levels. These computer programmes integrate innovative tools, such as a computerized laboratory, simulation, and visual data bases, with supportive pedagogical instruments.

CET has also developed learning materials (pupils workbooks, teacher's guides and kits) for Technological Literacy at the elementary school level in cooperation with the Curriculum Division of the Ministry of Education of Israel and is also developing materials for a general Technology course introduced at the high school level.

A great number of study books, exercise books, experiment books, etc. in technological subjects like electricity, control, communication for grades 10-12 have also been published by CET in the last few years.

The widespread acceptance and use of these programmes and learning materials, has led CET to become one of the largest publishers of textbooks and learning materials in Israel, producing some seven hundred titles.

For more information contact:

Israel S. Silberstein
Centre for Education Technology (CET)
16 Klausner Street
Tel-Aviv 61394
ISRAEL

Other New Additions

In addition to the Israel Centre for Technology ICASE welcomes the following members:

Institutional Member
Please contact:
Dr. Ester B. Ogena
Department of Science and Technology
Science Education Institute
Bicutan Tagig
PO Box 1412 Manila
Philippines

Full Member
Please contact:
Harry Silfverberg
Finnish Association for Research in Maths and Science Ed.
Department of Teacher Education
University of Tampere
PO Box 607, 33101 Tampere
Finland
Coming Events

THE 9TH ICASE-ASIAN SYMPOSIUM
Bangkok, Thailand
6-10 December 1994

Theme
The theme of this 9th ICASE-Asian Symposium will be “Increasing the effectiveness of Science Teaching in the Classroom: A Challenge for Scientific and Technological Literacy for All.”

Sub-themes for concurrent sessions include:
- The use of computers in the teaching of science subjects.
- Promoting awareness of environmental problems and issues through the teaching of science.
- The use of locally produced equipment and teaching materials.

Objectives
The symposium will provide an opportunity for science educators and teachers in the Asian region to meet together in order to:
- share ideas and experiences on science and technology teaching.
- interact with educators in the fields of biology, chemistry, physics, mathematics and primary science.
- recognize the need for scientific and technological literacy for all.

Organizer
The Institute for the Promotion of Teaching Science and Technology and The Science Society of Thailand under the Patronage of His Majesty the King in conjunction with The Association of Science and Technology Education
The Science Teachers Association of Thailand supported by ICASE and UNESCO PROAP Bangkok

Programme
There will be plenary, keynote lectures, symposium lectures, workshops, poster displays and exhibits.

Details of the programme will be available in the second announcement.

Call for Papers
Contributed papers highlighting news and recent development in the areas covered by the symposium are invited.

The closing date for receipts of titles and abstracts (not exceeding one page) is June 30, 1994. The abstracts should be camera-ready on A4-size paper (297 mm x 210 mm) the text must be typed within the frame of 220 mm x 150 mm. The name of the speaker is to be underlined. Instructions for typing camera-ready manuscripts may be requested from the secretary of the organizing committee. Full Text of accepted papers must be submitted by September 1, 1994. On request, the secretariat of the symposium will send a personal invitation for participation in the symposium. It should be understood that such an invitation is only meant to help participants raise travel funds or obtain visas, and is not a commitment on the part of the organizers to provide any financial support.

Language
The language of the symposium will be English. The national language is Thai. English is widely spoken in tourist centers and hotels.

Local Information
Climate: December is the dry and comfortable month in Bangkok with the temperature ranging between 20°-29°C.
Visa: Those visitors who require a visa to enter Thailand should consult the nearest Royal Thai Embassy or Consular Office for visa information.

Accommodation
Accommodation will be reserved upon request. Special room rates will be arranged at the venue of the symposium and in nearby hotels, details of which are available from the secretariat.

Registration Fees
The registration fees are as follows:
- Active participants
  - Before September 30, 1994 U.S. $100
  - After September 30, 1994 U.S. $120
- Accompanying person U.S. $80

(All payments must be in Banker’s order or Bank draft)

Chairman:
Asst. Prof. Charuni Sutabutr, Director
The Institute for the Promotion of Teaching Science and Technology (IPST)
924 Sukhumvit Road
Bangkok 10110, THAILAND
Tel. +662 392-3772
Fax. +662 381-0750
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GLOBAL CHANGE CURRICULUM WORKSHOP

The workshop, jointly organised by COSTED (Committee on Science and Technology in Developing Countries) and ICSU CTS and held in Madras, India, November 22-26, 1993, was designed to:

1. Make participants more familiar with the Global Change interdisciplinary teaching materials prepared for the student 16-19 age group by CTS;
2. Suggest modifications and additions to these materials taking note of the developing country educational systems; and
3. Plan new educational units on Global Change.

The workshop was run by Professor Joe Stoltman, secretary of CTS and Professor of Geography at Western Michigan University, Kalamazoo, Michigan, USA. He was ably assisted by Peter Nicholson and Graham Lenton, writing team members from the UK. The hard work of hosting and organizing the workshop was admirably handled by Professor Roy Daniel, Dr. Babuji, Dr. Veena Ravichandran and the rest of the COSTED team. The participants, from a number of Asian countries, examined the first four units and detailed amendments and additions which COSTED plans to collate and print. All participants welcomed the materials as worthy additions to the resources available to teachers, although opinions were mixed about the ability of teachers in the Asian region to incorporate much of the material into their current teaching programmes.

This workshop was seen as important from the ICASE viewpoint as the goals of the Global Change materials are in line with steps to enhance scientific and technological literacy—a major thrust by ICASE within Project 2000+. Comments that such materials may be difficult to include in the teaching programme are thus a matter of concern. The challenge we face is to find ways to incorporate material that attempt to promote data interpretation, decision making and communication skills, if the wish to move towards more meaningful science teaching is welcomed by teachers and teachers wish to meet the goals being set for Project 2000+. Unfortunately curricula design rarely illustrate ways of promoting such skills, even though objectives usually allude to them. Teachers having short term goals and adhering only to the viewpoint of teaching so that “students pass the examination” are not likely to welcome the units.

ICASE strongly supports these materials and wishes to promote their trialing and evaluation in schools around the world. If any teacher would like to be part of these trials, teaching some or all the units (or activities from the units) and sending feedback to Jack Holbrook (address given under list of ICASE officers). Jack will be pleased to send a set of the units (unfortunately, at present, without the suggested amendments at the Madras workshop).

(Above) Some of the participants at the workshop in Madras, India
1994

April 7–23
Sixth Edinburgh International Science Festival
Location: Edinburgh, Scotland
Contact: Marion-Jane Pate, Assistant Chief Executive, Edinburgh Science Festival Ltd., 1 Broughton Market, Edinburgh EH3 6 NU, Scotland, UK
Following the success of the 1993 Festival which attracted over 200,000 people to 367 events, preparations for the 1994 Festival are now well in hand. Major themes include: (1) Being the right size; (2) Molecule of the day; (3) Science myths of out time. In addition, exhibitions, talks, debates, workshops (including Madlab, Computer Arcade, FUNDamental Physics, Science Dome), family events, performances, tours, and conferences will be featured in the program.

April 10–13
International Symposium: When Science Becomes Culture
Location: Montréal, Québec, Canada
Contact: Quand la science se fait culture, Université du Québec à Montréal, CP 8888, succursale A, Montréal, Québec, Canada H3C 3P8
Symposium themes include: (1) Realities of today’s scientific and technological culture—how far have we come? National reports on accomplishments; (2) Methods and practices of scientific and technological culture; (3) Practitioners of scientific and technological culture; (4) Sharing of knowledge and democratic accountability; (5) Taking up the challenge of sustainable economic development. The deadline for receiving full papers (conditions apply) for consideration by the scientific committee is 1st February 1994.

June
Schola Ludus: Science and the Public
Location: Bratislava, Slovak Republic
Contact: Schola Ludus, Faculty of Mathematics and Physics, Comenius University, Mlynská dolina F2, 2 15 Bratislava, Slovakia
This international conference will feature four themes: (1) Building up a hands-on science center; (2) Supporting lifelong education; (3) Building up an open and consistent learning about the universe and life on Earth; (4) Finding the essence of real scientific, human, technical and environmental problems. The conference sessions will be conducted in English and Slovak/Czech.

July 4–8
CONASTA 43
Location: Launceston, Tasmania, Australia
Contact: Donna McWilliam, CONASTA 43, PO Box 1922, Launceston Tas 7250, Australia, Fax (003) 34 2598
The theme for the 43rd annual conference of the Australian Science Teachers Association (CONASTA 43) is ‘In from the cold.’ The program brings contemporary developments and information to teachers within an atmosphere of support. Hear about new ideas and approaches in science and technology, keep abreast of latest developments, evaluate new resources, and meet teachers from all over Australia and beyond. Keynote addresses, workshops, displays, social events and a family program make Launceston an exciting place to be in July 94!

July 17–22
Fifth InterAmerican Conference on Physics Education
Location: Texas, USA
Contact: Robert Beck Clark, Texas A&M University, College Station, Texas, 77843-4242, USA, Fax +1-409-845-2590
The theme of ‘Building bridges for cooperation in physics education’ will feature sessions in English and Spanish.

July 27–August 10
London International Youth Science Forum
Location: London, UK
Contact: LIYSF, PO Box 159, London SW10 9QX, UK
The Science Forum is the principal annual meeting in Britain of young scientists. Over three hundred students attend from some fifty nations to make this an international event of major significance. The program features lectures, seminars and demonstrations from leading scientific names, and an extensive range of visits to university and industrial research establishments.

August 8–12
13th International Conference on Chemical Education
Location: San Juan, Puerto Rico
Contact: Ram S. Lamba, Chairman 13th ICCE, Inter American University of Puerto Rico, PO Box 191293, San Juan PR 00919-1293
This will be the first time that an ICCE meeting will have been held in the Caribbean Region. The objective of this conference is to bring together chemistry teachers from the pre-college and college levels to share ideas and learn from each other about innovations in the teaching and learning of chemistry. The theme is 'Chemistry: The Key to the Future.' The Conference will feature plenary lectures, symposia, lecture presentations, workshops, poster sessions and exhibitions. Scientists and science educators from around the world will report their work.
The World Population Explosion and Related Issues: The I.A.S.C. Questionnaire Results

\section*{A Need for Unity in Diversity}

by B. J. K. Tricker

isle of Wight, United Kingdom

\section*{Abstract}

International Association of Science Clubs sees the human population explosion as the greatest problem ever to have been faced by humans. It may be portrayed by one simple graph which should provoke thought, discussion and action.

The most important answers to the I.A.S.C. Opinion Forum Questionnaire show:

1. that the respondents would, on average, like to see a lower world population than exists at present;
2. that they see this as unlikely;
3. that measures should be taken to contain the problem;
4. that young people, once they know about the world population problem, resolve, on average, that they should have smaller families than they had previously considered appropriate.

Among the factors contributing to population increase is a considerable ‘ostrich effect’—failure to face up to the problem, and even hiding knowledge of it from others.

The UNFPA effort, while admirable, praiseworthy and considerable is seen as being mathematically inadequate.

I.A.S.C. therefore welcomed the 1993 New Delhi Conference of National Academies of Science which, having the word ‘population’ in its title, did not deviate from this, the most important issue in the history of humans.

I.A.S.C. is interested in running another forum of the kind that set the currently reported work in motion, provided that it is sponsored to an extent that its news is likely to have a significant world impact.

\section*{Introduction}

This paper is produced in response to Dame Anne McLaren, Vice President of the Royal Society of London acting on behalf of the President, Sir Michael Atiyah.


During this time there has been a growing awareness of the population problem, but it has also become evident that there is, even among intelligent people, an ‘ostrich effect’ of a hiding from what could be done. In the name of a better quality of life for more people, alternatively expressed as sustainable development, it seems foolish to suppress understanding.

The I.A.S.C. argument begins with the facts that the world is finite and in a state of complex and often delicate balances. It seems paramount that the world should not be overloaded with people, and as no one knows the limits, that nations should err on the side of caution.

The questions are a mixture of choices and invitations to express opinions. In this way we feel it has intellectual advantages over the pure multiple choice type of survey. Each batch of returns has been consistent in the points listed in the Abstract. Questions 2 c, d, and e contain the kind of contradictions one encounters in the social sciences and the replies given by the respondents are by no means exhaustive of all possibilities.

\section*{Aims}

1. To sample opinions on the population explosion and related issues.
2. To suggest action in the light of the findings.

\begin{table}[h]
\centering
\begin{tabular}{|l|l|l|l|}
\hline
Place & Issued & Returns received & Age range \\
\hline
Canberra 1988 & 375 & 64 international & 43: 11-21 \\
Sci Ed Int 9/91 & world wide & 29 (Sweden and Australia) & 16-18 \\
ASE, U.K. 1/93 & 30 & 60 mostly English & 52: 12-13 8: adult \\
S.R.P. III = I.A.S.C.’s journal 1/93 & to Membership and others & 256 mostly English & 13-17 \\
Project 2000+ & 250 & 10 international & adult \\
\hline
\end{tabular}
\caption{Distribution}
\end{table}

\section*{RESULTS}

Respondents were not called upon to justify their replies. They were free to leave blanks, and also offer further words as they felt inclined.
1. There are now more people alive in the world today than have ever lived in total before.
   (a) Is this idea new to you? Yes: 20% No: 74%
   (b) Do you believe it? Yes: 79% No: 15%
   Not sure: 2%

2. The population graph shows no signs of leveling off.
   (a) Do you see this as a serious matter?
      Yes: 90% No: 4%
   (b) Nature should be allowed to take its course: 14%
      Measures should be taken towards a steady level: 72%
   (c), (d), (e) Please see Appendix 1.

3. (a) Do you agree that the greater number of people, the less the room for wildlife?
       Yes: 79% No: 12%
   (b) Does this concern you? Yes: 73% No: 17%

4. Would you like to have children of your own in time?
   (Those with children already were counted "yes.")
   Yes: 85% No: 4%

5. How many children would you like to have?
   No. of children
      0, 0-1, 1, 1-2, 2, 2-3, 3, 3-4, 4, 4-5, 5, 5-6, 6
   No. of respondents
      13, 1, 14, 20, 174, 33, 41, 6, 11, 0, 0, 0
   Average: 2.13 children per couple

6. In view of world overcrowding, how many children do you think you should have?
   No. of children
      0, 0-1, 1, 1-2, 2, 2-3, 3, 3-4, 4, 4-5, 5, 5-6, 6
   No. of respondents
      20, 6, 72, 46, 140, 14, 6, 3, 2, 0, 0, 0
   Average: 1.67 children per couple

7. What do you consider to be the optimum level for the world's human population assuming that it is desirable for all people to have a fair quality of life, etc.?

   Opinions on Optimum World Population

In the discussion and analysis the following figures based on U.N. data will be mentioned:
Year in which the population reached this number:
1 2 3 4 5 6
Number in billions

8. Please refer to the graph at the end of question 8. In order to keep the expense of responding to the questionnaire down—the copying was done by the respondents at their own expense—it was necessary to keep it to a single page. It was not possible to explain the inset graph in the space available, and it is evident that people interpreted it in different ways. Choices 6 and 7 were meant to represent population low levels after some catastrophic event, but it seemed that some chose 6 or 7 without being aware that a prior catastrophe was implied. However, the following table is, it is felt, still worth recording.

   Inset graph number
   1, 6, 7, 2, 3, 4, 5
   number of respondents:
   (a) most likely to happen
      113, 3, 6, 141, 15, 8, 4
   (b) preferred
      3, 11, 15, 43, 135, 69, 22

   Discussion
   While some maintain that social science is too confused to warrant calling it a science, thinking citizens have to make decisions based on the best evidence available at the time.

   It is increasingly accepted that the world population explosion is unsustainable and also that the longer it continues unabated the worse are the prospects we are leaving for future generations. Ninety percent of the respondents saw the matter to be serious.

   Re: 2(b), if human nature is taken to be a part of nature, the choices given could be taken to mean much the same thing. The 14% wanting nature to take its course were not asked whether planned intervention came within their interpretation, but the 72% wanting measures taken show a clear majority for action.
Answers to 2(c), (d) and (e), (Appendix 1), being
unencoded, indicate topics which were uppermost in the
minds of the respondents. There is much argument on
population issues as to which factors are causes, which are
effects, which are partially related and to what degrees.
The author’s opinion is that with such complex issues,
attacks on the problems should be made at all points
possible. In the present context of the population problem,
he last word goes to a citizen of the U.S.A. at a UNFPA
meeting in New York held in March 1993, “The best
contraceptive is the contraceptive.” He was frustrated by
his indirect approaches being advocated.
The seven most commonly named consequences which go
with overcrowding with, in brackets, the number of times
each was mentioned, were as follows: 1. disease and bad
health (89); 2. starvation and famine (85); 3. poverty (62);
1. unemployment (62); 5. food shortages (60); 6. poor
housing, slums, shanty towns and squalor (53);
7. pollution (51).

Similarly, the most acceptable population control measures
were: 1. contraception and birth control (165);
2. & 3. family planning/counseling (44), and education
(44); 4. legal restrictions (29); 5. & 6. incentives for
small families (25), and abortion (25); 7. taxes on
children (13).

Inacceptable control measures were:
1. killing (unspecified) (69); 2. & 3. forced sterilization
(33), and genocide/ethnic cleansing (33);
4. & 5. infanticide (32), and abortion (32); 6. legal
restrictions (23); 7. euthanasia (14)

Three respondents mentioned the point that famine relief
efforts to invest in misery for greater numbers in the long
run. A comment by a respondent in CSIRO’s H.Q. in
Canberra makes a powerful summary, “I think the time has
come when necessity overrides people’s rights to have
limited families.” State care for the elderly would go a
long way towards removing perhaps the most valid reason
for having large families in many parts of the world.

Question 3. The high value placed on wildlife and,
although no one in the survey mentioned it specifically,
genetic diversity, is encouraging, but the 17% declaring no
care to the author, seem alarming. Over 100
years ago, John Stuart Mill declared that the world would be
a poorer place if everywhere was altered for the
requirements of Man. It has to be admitted that our
species is responsible for so much confusion and havoc
that a more modest approach than to consider ourselves the
ultimate beings is required.

Questions 4, 5 and 6. There is a small but growing number
of people who believe the world is no longer a fit place for
children of their own. However, I do not believe that this
category will be large enough to make a significant turn in
the population curve, at least for some time yet. The 85%
hoping to have children of their own represent an overall
feeling of optimism which, if the small family becomes
more widely accepted and large ones become viewed, with
the spread of understanding, as selfish, could lead the way
to that glorious heaven on earth so far always just round
the corner.

The table of responses to questions 5 and 6 show an
overall willingness to accommodate; a desire for an
average of 2.13 children per couple being reduced to an
average of 1.67 in the light of knowledge of the world
population explosion. Several contributions considered
the Chinese control methods unacceptable, but it has to be
admitted that the Chinese solution is the only one to have
worked on a large scale so far (I.A.S.C. information from
Beijing states that the present Chinese population growth is
1% per year, the controls being concentrated on cities. It
would appear that their methods, whatever you may think
of them, are adjustable to governmental perceptions.)
Another point to be made before returning to the start of
this paragraph is that population decline need no longer be
equated with decrease in national strength. An economy
large enough to support modern technology will guarantee
both that and a rising quality of life for its citizens in
material terms. Alarm expressed when some populations
are seen to decline or be near to it is here considered to be
outdated.

Thus the willingness to decrease family size as a result of
education could be the voluntary answer, and being
voluntary, more positively acceptable than solutions which
are seen as being imposed. The investment must come in
the education, and just at present, every nine months there
is a new population the size of that of France to be
educated which did not exist before.

Question 8. The vast majority envisage the population will
go above what they think would be best. Ten respondents
were in the happy position of believing that what is most
likely to happen will be the same as they think best, while
four saw it settling below their idea of their preferred level.
The statements in this paragraph depend, of course, on
inspection of the individual returns.

The UNFPA reports that its goals for the year 2000
include:

- reducing the number of children born per woman in
order to reach the UN “medium variant” population
which is shown on Fig. 3 or Appendix 2;
- increasing female literacy to at least 70% and
achieving universal enrollment of girls in primary
schools;
- increasing contraceptive use to at least 59%
I question the adequacy of this last point. If 40% of women are not guarded by contraceptives, this means that as many women as lived in the early 1940s will not be guarded. The clock is thus set back 50 years, and in 50 years time the explosion of population will be again at the level it is today. Are we H. Sapiens or H. Stultus? The money required is but a fraction of that spent on armaments. To plan to guard all women now would be economically sound in the long term. Floods start through gaps.

The wishes of the respondents to the Opinion Forum reported here favor what the UN call their “medium low variant,” (labeled on Fig. 3, Appendix 2), not the medium one. Their preference, were it to be achieved, would ease environmental stress whereas the medium curve will exacerbate it.

The series of wars, famines, climatic and ecological disturbances of today make one wonder how near we are to the catastrophe level indicated by point 1 of the inset graph of the questionnaire. It has certainly arrived locally as far as those subjected to the stresses of war and famine are concerned. Crisis points for the varying hare (Appendix 2, Fig. 2) arrive without warning.

National planning must take account of two main headings:
1. internal considerations,
2. the nation’s effect on the world environment.

Conclusions

A. General
1. There is much concern over the world population explosion, especially among the young people of today who will have to live with its consequences.
2. This concern is expressed in the I.A.S.C. Opinion Forum, the most important result of which is the general voluntary desire to have smaller families.
3. An adequate education program is paramount, backed by practical measures which at present, while growing, appear to be inadequate for the rapidly worsening situation.

B. Particular
1. The work started at the International Young Peoples Forum in Canberra in 1988 should be repeated when there is a promise of financial backing sufficient to enable a significant world impact to be achieved. Any organization willing to sponsor this event is invited to send word to the I.A.S.C. Headquarters.
2. In the meantime I.A.S.C.’s Chairman, Professor V. S. Griffiths, and the Committee strongly suggest that organizations world-wide collect their own data using the I.A.S.C. Questionnaire. Such data collection will greatly expand dialog and heighten awareness of the global concern.

Acknowledgments

The author wishes to thank all those who have responded to our Opinion Forum, and also all those who so kindly made provisions enabling returns to be possible.

In particular thanks are due to the Australian taxpayers who sponsored the Canberra Forum in 1988 through CSIRO and the Australian National University. We also thank the Australian Academy of Science for kindly allowing the Forum to hold its final Plenary Session in their remarkable building.

We acknowledge also the work done by members of staff of the following establishments in organizing class returns; Hvitfeldsga Gymnasiet; Gothenburg; Eton College; Loughborough Grammar School; Cheltenham College Junior School; the U.K. Association for Science Education.

Financial help with this work has been provided by Mrs. A. V. Seller, Professor John Fines and C. K. V. Owen Esq. Printing was kindly done by J. Skipper Esq.

Abbreviations

ASE UK The United Kingdom Association for Science Education.
CSIRO The Commonwealth Scientific and Industrial Research Organisation of Australia.
IASC International Association of Science Clubs.
ICASE International Council of Associations for Science Education.
IYPF International Young Peoples Forum.
SRP A Science of Relative Peace, the journal of I.A.S.C.
UNFPA The United Nations Fund for Population Activities, now the U.N. Population Fund but which retains the letters UNFPA.

References

1. Day, J. P. (1985). Calculations showing that there are more people alive today than have ever lived in total before. A Science of Relative Peace, I.
6. UNFPA. UNFPA report. This has no title other than UNFPA and is distinct from their annual reports. 8 pp. (220 East 42nd Street, New York 10017, U.S.A.)
APPENDIX 1

Responses to Questions 2(c), (d) and (e)

Table 2c–Consequences of overcrowding given

<table>
<thead>
<tr>
<th>Consequence</th>
<th>No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>bad health/disease</td>
<td>89</td>
</tr>
<tr>
<td>famine/starvation</td>
<td>85</td>
</tr>
<tr>
<td>poverty</td>
<td>62</td>
</tr>
<tr>
<td>unemployment</td>
<td>62</td>
</tr>
<tr>
<td>food shortages</td>
<td>60</td>
</tr>
<tr>
<td>poor housing, slums, shanties, squaller</td>
<td>53</td>
</tr>
<tr>
<td>pollution</td>
<td>51</td>
</tr>
<tr>
<td>strain on/exhaustion of resources</td>
<td>38</td>
</tr>
<tr>
<td>lack of space</td>
<td>24</td>
</tr>
<tr>
<td>lower quality of life/lower standard of living</td>
<td>19</td>
</tr>
<tr>
<td>destruction of habitats and natural environment wars</td>
<td>18</td>
</tr>
<tr>
<td>increase in crime</td>
<td>12</td>
</tr>
<tr>
<td>hygiene problems</td>
<td>12</td>
</tr>
<tr>
<td>more aggression and quarreling</td>
<td>10</td>
</tr>
<tr>
<td>deforestation</td>
<td>9</td>
</tr>
<tr>
<td>economic disorder and hardship</td>
<td>9</td>
</tr>
<tr>
<td>urban sprawl</td>
<td>7</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Consequence</th>
<th>No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>water shortages</td>
<td>6</td>
</tr>
<tr>
<td>over-cropping and obesity</td>
<td>6</td>
</tr>
<tr>
<td>desertification</td>
<td>6</td>
</tr>
<tr>
<td>overcrowded roads</td>
<td>5</td>
</tr>
<tr>
<td>bad education</td>
<td>4</td>
</tr>
<tr>
<td>overcrowded cities</td>
<td>3</td>
</tr>
<tr>
<td>social problems</td>
<td>3</td>
</tr>
<tr>
<td>premature deaths</td>
<td>3</td>
</tr>
<tr>
<td>general shortages</td>
<td>2</td>
</tr>
<tr>
<td>environmental pressures</td>
<td>2</td>
</tr>
<tr>
<td>congestion</td>
<td>2</td>
</tr>
<tr>
<td>waiting lists and queues</td>
<td>2</td>
</tr>
<tr>
<td>inflation</td>
<td>2</td>
</tr>
<tr>
<td>reduced medical care</td>
<td>2</td>
</tr>
<tr>
<td>less privacy/shared beds</td>
<td>2</td>
</tr>
<tr>
<td>global warming</td>
<td>2</td>
</tr>
<tr>
<td>extreme politics</td>
<td>1</td>
</tr>
<tr>
<td>ethnic unrest</td>
<td>1</td>
</tr>
<tr>
<td>more suicides</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 2d–Control measures given as unacceptable

<table>
<thead>
<tr>
<th>Measure</th>
<th>No.</th>
<th>Measure</th>
<th>No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>killing (unspecified)</td>
<td>69</td>
<td>taxes on children</td>
<td>12</td>
</tr>
<tr>
<td>forced sterilization</td>
<td>33</td>
<td>financial incentives</td>
<td>7</td>
</tr>
<tr>
<td>genocide/ethnic cleansing</td>
<td>33</td>
<td>abortion</td>
<td>5</td>
</tr>
<tr>
<td>infanticide</td>
<td>32</td>
<td>contraceptives</td>
<td>3</td>
</tr>
<tr>
<td>abortion</td>
<td>32</td>
<td>survival of the fittest</td>
<td>2</td>
</tr>
<tr>
<td>fines and other laws (including &quot;the Chinese method,&quot; 5)</td>
<td>24</td>
<td>eugenics</td>
<td>1</td>
</tr>
<tr>
<td>euthanasia</td>
<td>14</td>
<td>raising the legal age of marriage</td>
<td>1</td>
</tr>
</tbody>
</table>

APPENDIX 2

The Population Explosion

The I.A.S.C. sees the world population explosion as the greatest problem ever faced by Man. The need to face up to it must be apparent from the extraordinary steepness of the curve. A question put to the Oxford Global Forum of Religious and Political Leaders on Human Survival, (1988), on what should be done produced a long silence by some four hundred delegates! To whom then should we turn?

Effective I.A.S.C. work on the subject became possible at the International Young Peoples Forum we held in Canberra with the Australian Double Helix Club shortly after the Oxford Conference. Two thirds of the delegates (teenagers) said the extent of the problem was new to them. The general concern by all the delegates on both this and related environmental issues gives cause for positive hope since they had been put in the position of being ambassadors for the future. They were by no means stuck for ideas on what could be done within the limits generally acceptable in civilized societies.

The key result summarizing their returns to the questionnaire, when put in one sentence reads:

When these young people knew about the population explosion, they resolved, on average, that when they have children of their own they should have fewer than they had considered appropriate before knowing about the problem.

This finding has been repeated in Sweden (1992) along with disclosure of greater awareness of the problem. The population graph is beginning to appear in school textbooks, but calls to debate and action are few and far between.

Fig 1 (B. J. K. T., 1979) shows the curve along with two prognostications on a logarithmic scale. The steeper dashed line produces the acceleration suggested by the points for 1950, 1960, and 1970. The less steep dashed
line produces the trend of the curve from 1650 to 1950. While nobody would see the upper right hand areas of the graph as representing future reality, it is as well seriously to question tendencies in that direction. The new point now added for 1990 gives a glimmer of hope but no cause at all for complacency.

Population explosions are by no means the preserve of humans. There are “ladybird years,” “dandelion years,” “lemming years” and so on. Examine, for example, Fig. 2 of the records of the varying hare and the arctic fox. The phases nearest to the present human population explosion are those of the hare between the years 1859-1863 and 1881-1885. (You can imagine all the happy hares with their nice big happy families! Nothing seems in the way of apparently boundless economic expansion and growth!)

The United Nations was in 1987 predicting a world population of 10 billion for the year 2050, but seemed to have nothing to say on what might follow. Because the U.N. had made this prediction, it not only became accepted but was widely seen as going to happen without trouble. Fig. 3, plotted from their 1992 tables, acknowledges a range of possibilities, (added to Fig. 1 as the lines between two circles for 2150), but is so great as to be practically meaningless. However, the recognition of a diversity of possibilities is important.

The Hudson Bay records should tell us that there is no guarantee that population growth curves are always smooth or sigmoid in shape. Clearly, when a species exceeds its limits nature spares nothing to return it to lower levels. One can but imagine the stresses on the individual hares and foxes during the times of population collapse. Were they up to conceiving ideas such as “quality of life” and “sustainable development” they would have found them all blown away on the wind.

Man’s powers of forethought distinguish him from all other species. It must be within these realms that the solutions lie.

To us it is clear that an educational drive to show the world position to all people is the primary necessity. While efforts are being made in a few places, the current total world effort is nowhere near enough. The record of the Chinese is the only large scale planned achievement so far. The main valid reason for having large families, so that there are enough children left to give support in old age, is a matter for national governments to solve through the creation of welfare support.

If will-power, such as the resolve expressed at IYPF I turns the curve, there will be far less total stress than if control is left to the ruthlessness of nature. We must surely begin to view the world as a pint pot into which a quart’s worth of population just won’t go. Population levels should be aimed to give safety margins at the provincial level rather than be such that they are constantly hammering at the limits. All the details fill books so cannot be listed here in this brief article.

Were the education given for self control to be achieved—so that, for example, it becomes regarded as selfish to have more than one’s fair share of children—then, but not until, does it appear reasonable to entertain ideas of sustainable growth and a fair quality of life for all on the sort of time scale that we, on behalf of the generations of the future, should be considering. Something very close to only one child per adult, or two for a couple, is the requirement whether we like it or not.

(If you are interested in the further presentation of this argument, please make an appropriate offer to I.A.S.C. H.Q.)

![Figure 1](image1)

![Figure 2](image2)
Figure 3

Sources


Appendix 3

Calculations by Dr. J. P. Day.

Case 1.
Start with two people. Double the population every 30 years. Lifespan of each person: 30 years.

<table>
<thead>
<tr>
<th>Generation</th>
<th>Time/years</th>
<th>Number of People</th>
<th>Sum (old generations)</th>
<th>New Generations</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>1</td>
<td>30</td>
<td>2</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>60</td>
<td>2</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>90</td>
<td>2</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>120</td>
<td>2</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>5</td>
<td>150</td>
<td>2</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>N</td>
<td>(N-1) 30</td>
<td>2N-2</td>
<td>2</td>
<td>2N-2</td>
</tr>
</tbody>
</table>

Conclusion: New generation > Sum (old generations). In other words, given the above conditions, there are now more people alive today than have ever lived before.

Case 2.
Exponential Growth.

The Sum, S, is the area under the curve.

\[ S = \frac{1}{2} \cdot e^t \cdot dt. \]

\[ S = e^t \]

or, at any time, the Sum of those who have lived < the number of people alive at that moment.

Case 3.
Start with 2 people. Say each couple has 4 children at 30 years of age. Let the lifespan of each couple be 60 years.

<table>
<thead>
<tr>
<th>Generation</th>
<th>Time/years</th>
<th>New Generation still alive</th>
<th>Generation</th>
<th>Total alive</th>
<th>Sum of those deceased</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>0</td>
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<tr>
<td>2</td>
<td>30</td>
<td>4</td>
<td>2</td>
<td>6</td>
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</tr>
<tr>
<td>3</td>
<td>60</td>
<td>8</td>
<td>4</td>
<td>12</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>90</td>
<td>16</td>
<td>8</td>
<td>24</td>
<td>6</td>
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<tr>
<td>5</td>
<td>120</td>
<td>32</td>
<td>16</td>
<td>48</td>
<td>14</td>
</tr>
<tr>
<td>6</td>
<td>150</td>
<td>64</td>
<td>32</td>
<td>96</td>
<td>30</td>
</tr>
</tbody>
</table>

i.e., the Sum of those who have lived is very much less than the number of people living at any given time.

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Knapp Hill, South Harting
Petersfield GU31 5LR, UK
SCIENCE EDUCATION IN THE CARIBBEAN
Winston King
Faculty of Education
University of the West Indies
Barbados

Introduction
For the purpose of this paper, the Caribbean region embraces all the countries in the Caribbean Community (Caricom) group. These countries range from Belize, on the Central American mainland, to Guyana on the South American mainland—a span of about 2,700 miles. Between these two countries lies an arc of islands: Jamaica, St. Kitts/Nevis, Antigua and Barbuda, Anguilla, Montserrat, Dominica, St. Lucia, St. Vincent and the Grenadines, Barbados, Grenada, and Trinidad and Tobago. The total population is approximately five million.

Each country has its own peculiarities in culture and aspirations, yet they are quite similar in many respects. The countries are at varying points along the development continuum and most are fully independent, but a few are still British colonies. The long history of a connection with Britain has meant that educational systems are largely patterned on the British system.

This paper seeks to trace the various influences on Caribbean science education, to examine some criticisms of science education, and points the way forward. Clearly there are certain imperatives if there is to be an increase in the quality of instruction in science. Of primary importance are: increased quality and quantity of teacher development activities; much stricter adherence to effective strategies of curriculum planning and implementation; and a deeper realization that the classroom/laboratory is where teaching/learning transactions survive or fail, depending on the students’ previous knowledge, needs and aspirations.

Science in the School Curriculum
Formal science instruction begins at the age of 5 with primary school. Although nursery education is developing in the region, the bulk of the activities are not owned or funded by governments. Science at the primary level is integrated, and all countries have well-organized curricula for this 5-11 age range. In some countries science forms part of the selection examination used for entry into the secondary school at 11+-13+. It seems that much more importance is accorded science education in the countries where it forms a part of the selection examination.

In the first two or three levels (ages 11-14) of the secondary school, science continues to be integrated. At age 13 or 14, students select from one or more of the separate sciences—biology, chemistry, physics or an integrated science course. At 16+ the regional examination body, the Caribbean Examination Council (CXC) examines in all the options mentioned.

After secondary school students may follow one of several pathways: (a) continue in the sciences and complete external examinations set by British (especially London and Cambridge) examination boards and possibly continue on to university, (b) enter a university with a four year degree program, (c) enter the teaching profession.

At teachers’ colleges, science is integrated, since the majority of graduates teach at the primary level. At University, science is separated into the traditional areas. Some university graduates return to that institution to pursue postgraduate diplomas and higher degrees.

Factors That Influenced Caribbean Science Education
Science education in the Caribbean has been, and continues to be, influenced by several factors, including socio-historical background; impact of international movements; development of science knowledge, skills and attitudes relevant to the Caribbean situation; rationalization of science as a part of the curriculum at all levels; intervention by external funding agencies; impact of regional and external examinations; design of strategies for teacher development in science. Some of these factors
need elaboration. The socio-historical background of the teaching of science is especially interesting.

The first attempts to establish science in the school curriculum failed due to a multiplicity of factors. Chief among these factors was the religious bodies’ reluctance to have newly freed slaves involved in studies, mainly agriculture, that were too closely related to the conditions before slavery was abolished. Added to this was the apparent stigma attached to “practical education” at that time when classical education was greatly sought after. Indeed the decision makers of the time were more interested in producing “pale replicas” of citizens of the Mother Country than producing persons who would be more suited to agriculturally-based Caribbean countries.

Various factors contributed to change the status of science education and the teaching of science in the Caribbean in the more recent past. These factors include: political changes resulting in the march to independence in the 60s; the establishment of the University College of the West Indies—especially the development of the Faculty of Medical Science (1952); Faculty of Natural Sciences (1954); Institute of Education (1953); Faculty of Agriculture (1962)—formerly the Imperial College of Tropical Agriculture (1927). Equally important were economic pressures—began in the 1950s as the expanding economy moved away from agriculture into industry and technology and social movements as citizens sought social identity and value of their own heritage. Finally, new advances in scientific knowledge brought science education into its own.

One can hardly doubt the important influence that international developments and trends have had, and continue to have, on Caribbean science education. There are few countries in the world that can claim no influence on their science education from developments in other countries.

One of the first, and perhaps one of the most long-lasting impacts from international science education, has been the child-centered approach. Resulting from a reaction to the mainly didactic, chalk-and-talk approach previously accepted as the sole method of teaching science, child-centered approaches are operationalized as discovery learning, learning by doing, and the inquiry approach.

But, there are other international movements that have impacted, and continue to impact science education in the Caribbean. For example, the matter of teaching by using the process approach. The primary science program in Trinidad and Tobago is built entirely on the process approach. This program has spawned the development of a series of textbooks, Science: A Process Approach of Trinidad and Tobago, which seeks to forge linkages between existing ideas and new experiences, testing the former against the evidence of these new experiences and situations.

Two other international movements or trends bear some mention—integrated science and teaching of science using the project approach. Indeed, it is interesting to note that both of these have seen their elaboration and refinement in the work of the Caribbean Examination Council (CXC) Science Syllabuses.

As Caribbean countries moved from colonial ties towards independence they were forced to become much more aware of the type of education that is most relevant and appropriate to the region’s development. These changes were even more critical as the countries attempted to move from mere producers of raw materials to manufacturers, inventors, and innovators in science and technology. Thus, from the vast body of knowledge and experiences that is science, Caribbean science educators have had to carve out the type of knowledge, skills and values that would be most important in the move towards industrialization and technological advances. Besides, there is the question of science education for citizenship and scientific literacy. And perhaps most pressing need to inculcate science values and attitudes so important in the development of a scientific spirit.

Deficiencies in Science Education in the Caribbean

Despite the various impacts mentioned above, one still discerns areas of deficiency. There is still too much of a didactic approach in the teaching of science. It is still very common to visit classrooms where topics such as leaves—structure and function, are being taught with magnificent drawings on the chalkboard and being copied by students. This situation is so paradoxical when one considers that just outside the window of the classroom there are all shapes and sizes of leaves which almost no one will ever notice.

Many are the reasons for the lack of use of the environment and the failure to link classroom with real life outside. First and foremost is the lack of knowledge and skills of science. The existence of inadequately trained and under-qualified teachers is a persistent problem in Caribbean schools. In some countries as many as 70% of the teachers at the primary level are untrained, with a sizable proportion of those not having the qualification to enter teachers’ training college. The secondary system also has a large percentage of untrained (graduate and non-graduate) teachers. Another deficiency that is obvious in Caribbean science teaching is the almost complete absence of aspects of technology.

Science education at the present time seems not to cater to the development of scientific literacy. Clearly, only a
small percentage, in some countries as little as 5-10%, go on to A-level, and an even smaller percentage to university science. Thus, science for living and literacy in the modern world needs to feature more prominently in the goals of teaching at all levels.

Mention has already been made of the problems encountered in planning and implementation of science curricula. Many of these programs geared towards improving teaching/learning in science have been built without proper research into what teachers and educators perceive as the purpose of science education. A recent research study among 629 primary teachers shows that the rank order of aims of primary science is loaded towards “knowledge of basic facts of science,” while the curriculum materials are geared towards problem-solving, understanding social implications of science and so on. This is a large discrepancy which requires further probing and investigation.

Towards the Future
So far we have looked at the various forces which influenced Caribbean science education and some of the deficiencies as seen by this writer. This section of the paper focuses on some of the ideas, concepts and methods that should provide relevant up-to-date science teaching/learning for all citizens. In a very real sense this section attempts to recommend a set of ideas that would chart the way forward.

It seems to me that there are certain areas in which we need to develop in the future. These areas include:
(a) more emphasis on out-of-school approaches—instead of placing full responsibility on the school, (b) more infusion of science-technology-society in the curricula at all levels, (c) a constructivist approach to science teaching—building instruction much more on the students’ ideas and concepts which they bring to the learning situation, (d) greater study of design of strategies for teacher development—teacher preparation that goes hand-in-hand with activities that enhance student learning.

In the case of teacher development, I have long suggested, that any program devised should focus on the following:
1. integrated content-methodology course;
2. school teaching experience with supervision, using an observation schedule;
3. experiences consistent with the nature of scientific inquiry resulting in an understanding of the processes of science;
4. activities leading to the development of a positive attitude to science and science instruction;
5. experiences that emphasize the interrelationship between science, technology and society, resulting in enhanced socio-environmental behaviors; and
6. activities emphasizing the constructivist learning model.

Summary
This brief paper has attempted to outline the situation in science education in the Caribbean. Clearly, there have been developments and improvements in science education, especially over the last two decades. However, there is room for improvement in certain areas. Failure to make science education and teaching more relevant and meaningful to Caribbean learners will result in a perpetuation of what some consider as an impoverished scientific culture.

ICASE
The First 20 Years
1973-1993
A brief history
This new publication is a brief history of the International Council of Associations for Science Education.

It is not intended to be a comprehensive account, but rather an overview of the key happenings and milestones in the development of the organisation and the policies and strategies that have enabled it to reach its present position in the international community of science education.

It also looks forward to the future, especially to the turn of the century, and examines possible options for the continual development of ICASE as an umbrella organisation for science education associations and similar bodies.

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STS APPROACH WITHIN SCIENCE EDUCATION IN ITALY
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Italy

This article provides some information about the nature of STS education in Italy. It is always difficult to present the major trends in education in one's own country. Therefore, this paper will first sketch out our school system and outline the place of STS in the science curriculum, then provide an historical overview of existing projects and materials. The last section will discuss the main features of such materials and present some findings about their application in the classroom context.

STS IN THE CURRICULUM
As far as science teaching is concerned, the situation is as follows. Below age level 14, science was introduced only in 1964—unless some information about general aspects such as planetary motion or human anatomy may be considered science teaching. In the first eight years, the sciences are taught as integrated science; while, in the different streams of the upper secondary schools, the sciences are taught as separate subjects: physics, chemistry, biology, etc. It is a peculiarity of the Italian system that all the secondary schools streams have a rather extended common core of disciplines which includes the sciences. The sciences are therefore taught through almost all the curriculum.

STS education as such is not taught in a systematic way but some suggestions about STS issues are included in the programs. Let me briefly outline how this is done.

Primary School: Ages 6-11
At primary level, where science was taught in a very limited and didactic fashion, the Ministry in 1987 introduced a program, which includes science as one of the five fundamental curriculum areas.

Technology also is seen as an important aspect of science teaching. The new program states that:

Pupils should be aware of advantages and disadvantages bound to every human intervention and shall build a positive attitude toward the environment and technological progress and that students shall meet the surrounding world of manufacture and products and understand the connected problems associated with technological reality.

The problem of putting such goals into practice has to do with teachers education. Primary teachers in Italy usually don't have a university degree. They have studied science only in their secondary courses, which does not give an adequate preparation in theoretical foundations, and even less in experimental work.

A multi-year refresher plan for the Programs (PPANPSE) to involve all the primary school teachers was then decreed and the technical and scientific design of the plan was entrusted to the twenty regional institutes for educational research and teacher training in Italy (IRRSAE). The IRRSAE Piemonte developed a project of teachers training at a distance. The subject branches of such project cover each subject area. The Science branch proposes some teaching refresher units on the principal inquiry strategies and on the technological activities peculiar to Physics, Chemistry, Biology, Astronomy, Technology, Ecology.

The technology theme is treated by the PPANPSE in a teacher book, a teacher dossier which suggests a variety of activities, a teacher-trainer guide, a 30-minute video, a teacher video guide. However, at this primary school level, it is more a matter of technological activities, than STS.

Junior School: Ages 11-14
In 1964, with the unification of the junior school (11-14) a course, “observing nature” (Osservazioni naturali) was introduced; it was taught by the same teacher as the mathematics course. The course was not very successful: pupils observed textbooks more than nature, and learned by rote memory of information about animals and plants. In 1979, the course was changed to one is based, in principle, on practical work and even project work, done by the students in small groups with a substantial amount of general class discussion and planning. One of the aims of the new science program was that pupils should:

‘maturare il proprio senso di responsabilita’ nell’impatto con la natura e nella gestione delle sue risorse.’ (develop their responsibility as regard to nature and the management of natural resources)


However, science teaching in general and topics like these in particular are not for the most part dealt with in school practice. The mismatch between official program aims and reality is due to a variety of reasons, the most important of them being the lack of adequate teacher education.

In Italy all secondary level science teachers have a university degree in a specific scientific subject (biology or natural science; less frequently mathematics, rarely physics), but they have no special educational training.
Although they are supposed to teach integrated science, most of them have an orientation only towards the specific discipline of science they have studied. Besides that, the goals they emphasize are directed toward preparing students for further formal study. The STS issues seem therefore to be largely neglected.

Upper Secondary School: Ages 14-19
At upper secondary level the curriculum situation is almost opposite to the primary school just described. The national programs are very old and inadequate, and almost ignored by teachers: curriculum in the schools is established by tradition. Sciences are taught as separate disciplines, and their position in the general curriculum can vary a great deal. In the ‘licei’ sciences are considered as general culture subjects, in the ‘Istituti tecnici’ as a basis for technical courses and in most most other schools science is a secondary subject with very limited time allowed.

However, modification of the official program in a school are possible if an authorization is obtained from the MPI. Also the reverse process is possible (the MPI making a proposal to the school) and this is what happens now quite frequently at the upper secondary level. Since 1980, in an effort to merge the various experiences, the MPI proposed teaching experimental models to be adopted by the schools according to their specialization. Relevant features of these projects (perimentazioni assistite), according to the MPI are: (a) the knowledge of scientific and technological issues, fundamental for evolution of the production processes; (b) the training and formation, considered as a whole of logical competence, sustained by the personal attitudes toward evolution and change; (c) everlasting ties with the world of production and services.'

In the framework of these projects ‘school-work’ activities (such as visits to factories and stages for teachers and/or older students) are often organized. Such activities are meant to foster students awareness of the local technological environment and industrial production.

These projects, proposed and supported by the MPI, seem on the borders of STS education, their aims being more strictly those of pure technology education.

STS EDUCATION
The science and society approach, including the historical perspective and contemporary issues, has been of interest in Italy for more than a decade. And recently ‘Science and society’ was chosen as the theme of a conference—in memory of A. Bastai Prat—held in Torino, whose proceeding are published (Agnes et al., 1990).

However, as we have already seen, school curricula do not give official recognition to STS courses. In a system rigid and centralized like ours, it is difficult to devote much time to a subject not included in the official programs. STS issues are therefore introduced into the science courses on a more or less individual basis. No complete new course on STS has been produced, only materials which can be inserted at different stages and different levels in existing science courses. These add-on initiatives fall into several categories.

Environmental Education
An investigation using case studies concerning the introduction of Environmental Education in the educational systems of thirteen countries was recently carried out (Mayer, 1990). The findings show how environmental education can be a powerful instrument for introducing new aims and changes in the roles of the students and teacher. An attempt is also made to identify ‘quality indicators’ or criteria for evaluation of Environmental Education experiences.

According to the data, environmental education in Italy is quite widely spread at the compulsory school level (under age 14). The ecological aspect—mainly the problem of pollution—is dealt with on the basis of educational experiments due to teachers initiative (more often a single teacher with his/her pupils). School authority, local institutions, associations often give substantial encouragement and collaboration to these projects.

At upper secondary level, spontaneous initiatives are less common. Educational materials (Bastai, 1990) have been developed in the frame of a project known as “Uomo, ambiente, informazione” (Man, environment, information), which use our senses as means to collect and organize information from the environment.

Historical Approach
The historical approach to science roused much interest some years ago, fostered by political criticism, it rapidly expanded to very broad general issues such as the connection between science and capitalism. In many cases it gave rise to interesting collaboration between history, philosophy, and physics teachers. Materials (Baracca & Livi, 1976; Mattioli, 1979) in the field of social science and history of science had an influence on such initiatives. More recently, science historians, like Paolo Rossi (Sarton medal for history of science), have prepared sourcebooks of readings for schools.

The research group on history of physics of Pavia, in collaboration with the Deutsches Museum of Munchen, developed materials on historical experiments to be used in school. The same group has recently produced several interactive computer simulation of historical experiments.

The introduction of historical theme was certainly enhanced by the translation and adaptation of the Project Physics material (Bastai et al., 1977). The book ‘Calore,
materia e moto’ (Bastai, 1981) also contributed by weaving physics, history, and technology together.

Science and Weapons
A set of units on weapons to be used in school science or mathematics courses has been developed by a group of experts and teachers (Centro studi e documentazione Regis) in Torino. Another project (Bastai, 1990), called ICBlM, tries to show the interrelation between scientific, technological, military and political decision involved in the production of much sophisticated weapons.

Energy Education
As in many other industrialized countries, energy policies are fundamental to Italian economy, all the more so, since local energy resources are very scarce. The country is dependent on imported energy for more than 75% of consumption. A nuclear plant-building plan proposed years ago met, from the beginning, with strong opposition and was finally canned by national referendum. Hydro-electric power, available primarily in the Alpine region, is exploited already. Solar technology, which with our geographical position could make an important contribution, is not yet sufficiently developed.

It is no surprise, therefore, that Physics teachers have taken a special interest in energy education. The next section is devoted to energy projects.

Energy Projects
Since the so-called “energy crisis” broke out in the early 70s, some teachers have been working on new proposals to introduce issues such as the sources, uses and waste of energy throughout the world as well as the physical laws which govern energy transformation (Conforto et al., 1983). In the early 1980s, special lecture courses (Conforto et al., 1985) were given by experts on the various aspects of nuclear energy, its uses and risks. These courses, organized by a group of physicists and biologists from the University of Rome, were designed for use at the senior school level. A decision game surrounding home heating, used in the Association for Science Education (ASE) “Science in Society,” was translated and tried in Torino with excellent results (Brunatti et al., 1981).

Many other short ready-made packaged materials were designed to encourage flexible use. It was hoped and expected that teachers would choose material suitable for their own pupils and use in addition to or instead of their normal program of study.

Il Problema Dell’Energia (The problem of energy)
A first energy problem Project (Bastai, 1984; Viglietta, 1985) was developed in Turin by a group of university and secondary-school teachers.

The projects’ aims were: (a) To help the students to acquire information and analytic tools necessary for them to reach more thoughtful personal opinions on the energy problem; (b) to apply in a concrete and relevant context, concepts and methods taught in science courses; (c) to introduce the latest concepts and methods which were not yet taught in traditional science courses; and (d) to consider the complex relationship between science, technology, economical factors and political choices which characterize such a problem. The outcome was a set of 10 energy problem units (A.A.V.V., 1984), intended for use in Italian high schools (pupils aged 14-18).

The table presents the units grouped under four main themes. Emphasis is put on a systemic approach to the energy problem and just aspects of production.

<table>
<thead>
<tr>
<th>TABLE 1</th>
<th>The Problem of Energy</th>
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<tbody>
<tr>
<td>Theme</td>
<td>Units</td>
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<tr>
<td>Limits of growth</td>
<td>Consumptions</td>
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<td>Reserves and resources</td>
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<td>New methods of energy production</td>
<td>Nuclear fission</td>
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<td>Nuclear fusion</td>
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<td>Solar energy</td>
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<td>Energy distribution</td>
<td>Electrical energy networks</td>
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<td>Coal future perspective</td>
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<td>Final uses</td>
<td>Energy in the home</td>
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<td>Heating</td>
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<td>Efficient use of energy</td>
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Quaderni Scuola-Energia (School-energy books)
Another project on energy education in Italy, financed by the Department of Science, industries and energy agencies, was national in scale. It started in 1984 with a series of conferences and in-service teacher training courses. The final product was again a set of ten teaching-units (Viglietta, 1990) each written around a particular theme (Energy in the History, Energy & Economy, Energy & Environment, Energy Sources, Removable Energy, Electrical Energy, Energy Saving). One main difference, between these and the Turin materials, was the inclusion of a teacher’s guide in each volume. These guides suggested an organization for the teaching materials, outlined the approach, provided background materials, supplied answers to questions and solutions to problems in the text, and advised on how to prepare laboratory or fieldwork activities.

AIF Initiatives
A somewhat different Project on Energy Education was promoted by AIF—the professional association of physics
teachers in Italy. In 1984, an investigation from AIF revealed that, in the view of physics teachers, the second law of thermodynamics should be a major priority for in-service training. This topic was then chosen as the theme for an International Conference and for a course where secondary school teachers worked on three possible approaches to the second law: a macroscopic approach, a microscopic approach and a computer-based approach. The results of this work were published as a special edition of AIF Journal ‘La Fisica nella Scuola’ (1989).

MAIN FEATURES OF STS PROJECTS
Deciphering Technical Information
One of the main aims of the teaching materials was to improve the level of understanding of science, engineering, mathematical, statistical concepts, claims, and analytical methods. This was done by using more generally accessible explanations, case studies, and hands-on activities. Emphasis was on understanding what the experts say through a demystification of both terminology and phenomena.

As an example of such an approach let us consider the units: CONSUMPTION and RESOURCES. As one of the authors (Bastai, Prat 84) points out, the main goal in these units was to avoid simply giving a list of data, which would have been of little educational use, would probably be boring, and in many cases already available in books, newspapers, etc.

Some of the objectives for the ‘Energy Consumption Unit’ are as follows. Pupils should: (a) Understand the importance of reliable sources for data; (b) understand and apply in simple context economic indicators relevant to the problem (such as GNP, per capita quantities, elasticity coefficients, etc.); (c) understand the main assumptions on which medium and long term forecasts (or “scenarios”) are built; and (d) be aware of the difference between factual and political assumptions.

Appreciation of Social Context
Another important and somewhat more difficult aim is to bring out the complex interactions and trade-offs between scientific aspects of a problem and cultural, psychological, legal, institutional, economic, ethical impacts and influences. This would frame STS problems and potential solutions within a broad perspective, and help people to see why solutions should not be left to technical experts.

As an example of material fulfilling such an aim, let us look at the NUCLEAR ENERGY units. Here are some of the aims of these units. Students should learn to: (a) Apply basic physical concepts in order to understand the design of nuclear reactors; (b) understand and apply the basic techniques in the discussion of safety requirements (e.g., the probability tree) and the waste-disposal problem.

The units try to avoid two attitudes:
1. One is “don’t disturb the experts” position. People should insist on being informed and try to understand as far as possible the technical and political issues and the reasons on which decisions are taken.
2. The second is the “atom is the devil” attitude. The unit intends to stress that atomic technology can be understood by the layman as much—or as little—as any other technology. Shaping the Science Curriculum

STS instruction can be raised beyond the issue awareness level and become a force in shaping science curricula. An example of how this can be done is given in the ENERGY EFFICIENCY materials where the study of efficient use of energy is the ground for introducing topics like “availability” and “second order efficiency,” still largely neglected in current school teaching. Even when the new approach (Viglietta, 1990b) does not go beyond the conventional boundaries of science courses, it does build competence to investigate the STS energy issue.

IMPLEMENTING STS
Formal evaluation of a teaching program is not very common in Italy let alone on a subject like STS, which is still marginal in our school. However, some evaluation studies have been carried out on STS materials.

Project Physics Course
In coincidence with the publication of the project in Italy, the authors of the Italian edition organized a convention of teachers adopting the PPC course. Some problems connected with the adoption of the new program were discussed. The point was emphasized that the new approach was not only a matter of adding physical plus historic information, but to reach an “inside” integration. Obstacles to integration were felt as particularly strong in ITI (industrial school) for: (a) pupils have poor math preparation; (b) there is not a course in philosophy (as in “Licei”); and (c) the general history course (“parallel” to the physics course) cover Greece and Rome. In addition, the universities prepare both the physics and other teachers to be a specialist, thus increasing the difficulties for making connection between different subjects. Other concerns for the introduction of Italian PPC was noticed (Bastai, 1984).

The fact remains that it is very difficult to reach an equilibrium between the “Science” and “Society” components of such a course. In the usual physics course, there are some materials on the social relevance of scientific discoveries, but these are very superficial and often inaccurate. If the social aspect of science is stressed more deeply, there is a danger that the course may be based on the “ideas” of science, and not on science itself with its experimental and mathematical
components. This is a particular danger in a country like Italy, where teachers are not inclined to teach through experiments, and prefer chalk-and-talk methods.

A remedial action to such situation, undertaken by the PPC adapters, was a teacher training course that stressed the role of laboratory in the historical approach and the use of historical experiments.

As far as pupils reaction to the course is concerned, (Viglietta, 1980) conducted a study which confirmed results obtained by Aikenhead in 1974. The PPC course was found to provide more students with a positive image of science, in making science more relevant to them, and in stressing the interconnection between science and other subject of study. In addition, students' performance on the final examination were equivalent (or better) than control classes students. (It may be worth noticing that examination was carried out through oral assessment, traditional in Italian school.)

**Energy Units**

The preliminary version of the energy units "Il problema dell’energia" units were distributed to science teachers using professional teachers’ associations as a channel. Initial evaluation of these trial schools may be found in (Bastai et al., 1984). The assessment gathered accounts of the teaching situation from different points of view (a method sometimes called triangulation). A variety of instruments was used including: checklist to record classroom activities, teachers' reports, pupils evaluation scores, classroom discussion and outsider observer reports. Results showed that STS issues attracted students who had previously shown little interest in traditional approaches. However, a danger also appeared. This interest toward out-of-school aspects, STS, was only weakly linked to increased engagement in Physics content.

**Energy Efficiency Materials**

A small scale feasibility study was conducted using a preliminary version of the Energy efficiency unit (Sgrignoli & Viglietta, 1984, Viglietta, 1990c) in a few schools with teachers that were, in general, highly motivated (two classes of the units' authors were also included). All the teachers reported a relevant increase in the interest and the proficiency of the pupils. Pupils seemed to appreciate, in particular, the study of well known devices such as cars or washing machines instead of the tediously common abstract examples. On a wider and more objective scale, we received positive comments about the materials from science-educators and from many school-teachers. However, most teachers found the material more interesting for their own “intellectual development,” than for their classroom practice. Some wondered about teaching a topic they had not dealt with at the university and were just hearing about for the first time. On the other hand, teachers who were willing to apply the material complained that they had not been given all the help they needed.

A main cause of these pitfalls may have been the fact that the unit only contained the innovative material—material and activities which teachers had no previous experience. We also assumed that the traditional chapters, which needed to be covered, could easily be done with a conventional Physics textbook and that teachers would know how to merge the two components. Infusing the unit into their program of study left to the teacher. This increased the feeling of insecurity. Some experienced teachers reported they felt like beginners when using the unit.

Experience showed that construction phase trials in a few classes, followed by commercial distribution of the teaching material, is not enough to make an approach widely used. Materials for teacher-training on the subject, in-service courses, workshops and conferences are also be needed to support a new approach.

New materials were then prepared. These were designed to generate teachers confidence in the infusion process that would help pupils to achieve a deeper understanding of energy-related issues and to become more aware of the practical implications of the physics they learn. We also tried to place our approach in teacher preparation programs. For this reason, our teacher training not only referred to the content of the teaching unit but also included relevant energy issues, taken from current literature.

The training materials were used on many occasions and become the ground for a monograph (Viglietta, 1989). The monograph is intended mainly for teachers’ use, and contains suggestions for a revised teaching scheme about energy and its laws and about energy efficiency.

The new teaching-scheme was then applied in the context of the mentioned Project “Scuola-energia,” sponsored by the Department of Education and Energy Agencies. The “Scuola-energia” units will be published within the year. The Department of Science has promised to provide every secondary school in Italy with copies of it and extensive trials and evaluations of the use of the materials in the classrooms context have also been foreseen. It appears that a nationwide STS theme in Italian science teaching is underway.

**REFERENCES**


Sixth Edinburg International Science Festival
Edinburgh, Scotland
1-23 April 1994

Following the success of the 1993 Festival which attracted over 200,000 people to 367 events, preparations for the 1994 Festival are now well in hand.

Major themes include
- Being the right size, Molecule of the day, Science myths of out time

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STATUS OF WOMEN IN UNIVERSITY SCIENCE: A COMPARATIVE STUDY BETWEEN A PAKISTANI AND UNITED STATES UNIVERSITY

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Introduction
The scientific community has been identified as holding the Mertonian norms of communalism, universalism, organized skepticism, and disinterestedness. Holding the value of communalism implies that information generated by scientific inquiry should be available to all interested parties, while holders of the value of universalism propose that experimental ideas should be judged solely on the basis of their importance to science and not according to the source of the information. According to the norm of organized skepticism, experimental information should not be accepted easily, but should be carefully tested for accuracy. Finally, disinterestedness means that theories should be judged objectively (Merton, 1973).

Norms of this type have led to a scientific society which holds priority in scientific discovery as its ultimate reward. Since priority has such a high value in this society, the competition level in science is extremely high. This drive for priority leads to a high level of competition. Nowhere can this competition be seen as fiercely as at the entry level, where pursuit for the “right” post-doctorate position leads to the pursuit for the “right” tenure-track appointment (Traweek, 1988).

Values of this type should lead to desirable consequences as well. For example, it would seem that the values of communalism, universalism, and disinterestedness would lead to a society where the individual member is valued only for their contributions to science and without regard to gender or race. It is well documented, that this has not been the case. For example, Lise Meitner, an extraordinarily creative physicist, had to do her research under extremely difficult conditions. She:

was required to work in a converted carpenter’s shop with a detached entrance, so as not to fluster her male colleagues. When the British physicist Ernest Rutherford met Lise Meitner (1878-1968) for the first time, he exclaimed with astonishment: “Oh, I thought you were a man.” Meitner spent the rest of Rutherford’s visit playing the role of hostess to Mrs. Rutherford (Booth, 1989).

Some might argue that although this was the case in the past, in modern society female researchers and male researchers are considered equal. Unfortunately, this is not the case. As illustrated by Stephen Brush (1992), women have even begun to lose ground in recent years. This decline in the number of women entering the scientific and engineering fields has become an issue of major concern, since the United States is facing a future shortage in the number of science and engineering graduates (Atkinson, 1990).

Description of Study
In order to examine the situation of women in scientific research information about two universities, one in the United States and the other in Pakistan, was gathered from public sources. The two universities are both considered excellent universities in their respective countries. Our primary concern in data gathering was to examine the number of female professors in the sciences at both universities.

Indiana University is a public research university. It is a large university, which offers a wide range of opportunities for both undergraduate and graduate students. Indiana University is considered an excellent state university, which provides a well-rounded education for its students.

Since Indiana University is a large cosmopolitan university, we might expect that the number of female faculty as a percentage of the whole faculty in science and related fields would represent a respectable sum. As is plainly shown in Table 1, the number of full-time female
faculty members in science at Indiana University does not approach equity. If this is true of what is regarded as a progressive, liberal country, what might the situation be in a developing country?

The same information about full-time faculty was obtained from an autonomous (public) university in Pakistan. Quaid-a-Azam University Islamabad (QAU) was named after the founder of Pakistan, Quaid-a-Azam Mohammad Ali Jinnah. The university is located in Islamabad, the capital of Pakistan. QAU is considered an excellent university with students attending from all over Pakistan. Nearly two thousand students attend the university, which has sixteen departments and offers M.S., M.Phil., and Ph.D. degrees. Admission to the university is based on merit without regard to race, ethnicity, or gender. Pakistan, itself, is a developing Muslim country, and you would expect women to have few opportunities for professional careers. The results of our survey, shown in Table 1, were not what one would expect.

Table 1.

<table>
<thead>
<tr>
<th>Department</th>
<th>% Women USA</th>
<th>% Women Pakistan</th>
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</thead>
<tbody>
<tr>
<td>Biology</td>
<td>20</td>
<td>36</td>
</tr>
<tr>
<td>Chemistry</td>
<td>3</td>
<td>14</td>
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<tr>
<td>Computer Science</td>
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<td>0</td>
</tr>
<tr>
<td>Geology</td>
<td>4</td>
<td>0</td>
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<tr>
<td>Mathematics</td>
<td>3</td>
<td>0</td>
</tr>
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<td>Physics</td>
<td>4</td>
<td>13</td>
</tr>
<tr>
<td>All Sciences</td>
<td>8</td>
<td>16</td>
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Discussion

In neither country did the results approach parity. Since the United States has a population which is 50% female and Pakistan has a population which is 55% female, the expectation would be, if no gender discrimination exists, that the percentage of female science professors would be similar to the percentage in the general population. Women are definitely underrepresented in the professorial populations of these two universities. One can infer that similar findings might be the norm throughout university science communities in both countries. Because the two countries have very different cultures, the reason for these discrepancies are not the same.

In the United States it is well documented that females drop out of science at two sites along the pipeline. Female high school students are less likely than their male counterparts to choose science as an undergraduate major. The next point at which a large portion of female students leave occurs during graduate school. Female graduate students are less likely than male graduate students to complete their degree (Brush, 1991). Females who either fail to choose science or drop out during graduate school do so for a variety of reasons.

One reason for this failure to choose science may relate to the negative male stereotype of the scientist. Current research shows that the scientific image held by many American students is that of a white male nerd (Schibeci, 1986). Because the image is both male and negative, females are less likely than males to identify with that image. Since students are more likely to choose careers with which they can identify, science careers are not likely to be chosen by young females (Rossi, 1965). Females are also less likely to believe that they are capable of doing science.

The stereotypical image of the scientist is not, however, the primary reason that female students fail to complete their graduate programs. Instead they probably drop out due to the culture in which they find themselves. The scientific community demands a great deal of its members. These demands may be greater for females than they are for males. For example, the age at which most scientific professionals establish themselves coincides with the age at which most women have children. Since their male counterparts can delay having their families, women often feel that they must choose between their careers as scientists and having a family (Zuckerman, Cole, and Bruer, 1991). While women rarely encounter overt discrimination, covert discrimination still occurs. Women may encounter a range of "microinequities" as they traverse the ladder of scientific success. These microinequities range from being called on less frequently in class, lower likelihood of being appointed to powerful committees, and decreased probability of having adequate resources for teaching and research. These inequities prevent women from being as productive as they can be (Widnall, 1989).

Other practices that prevent women from participating in the sciences at rates equal to men in the United States occur at two levels. Women graduating from high school fail to choose science as a career, because they feel they are not capable of doing science and because the stereotypical image of the profession does not match with the self-image of most females. Women fail to complete their education in the sciences, because they are confronted with a set of community standards that many women believe are not compatible with their life goals. Women also face a wide variety of small obstacles that are usually not faced by their male counterparts. These small obstacles are additive in nature, and may lead to a decision on the part of women that the prize is not worth the effort.

The situation in Pakistan has not been as well studied. We can make a few general conclusions based on the culture and socioeconomic status of the country. Women, for the
most part, in Pakistan have a secondary status. Males and females are not allowed to attend school together until they reach college. The boys' schools are often better equipped for the teaching of science than the girls' schools (IPSET, 1989). The most important aspect of a girls' education is that it makes her attractive to future husband prospects (Hayes, 1972). As a result, only 47% of the girls of primary age are enrolled in schools. In rural areas this number drops to 37%. The percentage continues to drop as female students reach middle school age (20%) and as they reach high school age (10%) (Bhatti, 1986). Since few girls' schools are equipped to teach science, the number of females prepared to go on in the sciences at the college level is extremely low. The plight of the rural female is especially dire. Not only does she live in an area where schools are poorly equipped and understaffed, but also she lives within a tradition-bound culture, which precludes her even thinking about a career in science.

The female in Pakistani society rarely chooses a career in science, because few Pakistani females complete high school. For those female students that do complete high school, science careers are still not an option, because the single-sex schools which they must attend are rarely equipped or staffed to teach science (Planning Commission, 1987).

It is interesting to note that although neither university approaches equity in science the Pakistani school has twice the percentage of female faculty as the American school. There are two possible reasons for this inequality. In Pakistan one method by which upper-class females can increase their attractiveness for possible husbands is by increasing their level of education. One of the fields which women have chosen is science. The choice of science appears to be the result of the freedom which Pakistani females experience when they attend a university. Pakistani females may deliberately choose this field of study, because it is a traditionally male field of study.

The other reason Pakistani females choose science as a field of study may be the inadvertent result of their single-sex education. There is some evidence that when female students are in single-sex classrooms, they learn better. This may be due to the absence of males in the classroom. This absence may allow female students to more fully express themselves, since they no longer need to fear being seen as unfeminine by males.

**Recommendations**

It is clear that both countries need to improve the participation of women in science, however, the recommendations for that improvement differ for each country. In the United States we need to improve the message that we are sending to young women. We must convince them that they are capable of doing science, and that the stereotypical image of the scientist is a false one. This can best be accomplished by developing mentoring relationships between schools and scientists.

Additionally, the climate of the scientific community needs to be changed. We must develop a community that allows women to flourish as men have. In order to do this we must begin by eliminating the push for tenure. No one should have to choose between having a family and having a career. New methods for establishing tenure need to be developed. The pile of microinequities through which women have to dig in order to develop as scientists must also be eliminated so that women can become as productive as men in the sciences.

Although the problem in Pakistan has not been as well studied as the United States, certain steps for improving the participation of women in science and technology can be taken. We must begin by improving the girls' schools in Pakistan with particular attention being paid to rural schools, where 75% of the population lives. Teachers need to be provided with adequate equipment and provided with instruction in using local resources. Local resources should be used so that students develop an awareness of the science around them not just the science in books.

Along with improvement in the girls' schools, females should be given incentives to participate in science programs in college. Scholarships, job sureties, and female hostels should be provided so that more female students are attracted to science programs. Also, the attitude toward female scientists at the public and government level must be changed so that the climate is more favorable for females.

Although all of the changes are far-reaching, they should result in an improvement in the number of females participating in science in both countries. We can potentially double the number of scientists if we improve the climate for women.

**Bibliography**


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TEACHING SCIENCE TO VISUALLY IMPAIRED STUDENTS

Practical Science and Drawing Science Diagrams with Blind Students Integrated Into a Nigerian Secondary School

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Former Head of Biology
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Boys’ Secondary School
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BACKGROUND

Boys’ Secondary School, Gindiri, Nigeria was the first Nigerian Secondary School to integrate a blind student and thus open up secondary education to blind Nigerians. This was in 1957 and the blind student, Bitrus Gani gained a Division I in his West African School Certificate which included a credit in Agricultural Science. He went on to study Physiotherapy at the London School of Physiotherapy. Other blind students followed him into Gindiri Boys’ and other secondary schools. As far as science is concerned they were and are mainly restricted to Health Science or Biology, with a few “branching out” into agricultural science. This science was and largely still is for the most part restricted to the theoretical parts of the syllabus, with practical work and the drawing of diagrams considered impossible for blind students. The West African Examinations Council excuses blind candidates from practical papers in science subjects.

The author taught biology, chemistry and integrated science at Boys’ Secondary School, Gindiri from 1978 to 1990 and became interested in involving blind students in practical work and the drawing of diagrams. The apparatus and techniques used for the teaching of diagrams and of two science topics are described.

DIAGRAMS

The various science syllabi are rich in diagrams which the student is expected to draw. This includes copying from the textbook or blackboard, and drawing actual specimens, sets of apparatus, etc.

Using a smooth rubber mat, a suitable plastic or Melinex sheet and a special drawing tool, blind students can be taught to draw. A raised (feitable) line is produced. However this imported equipment is very expensive so local alternatives were sought.

Car mats, smooth on one side, are available freely and one of these cut into four makes suitable sized mats. The elaborate system of clips, pins, etc., used to fix the drawing sheet to the imported can be replaced with a film of water which holds the plastic sheet in place (and is, itself, a good demonstration of the use of surface tension).

Various types of polythene sheets were bought and tried. The best turned out to be the polythene which a local firm (Nasco) used for their corn flakes. They kindly donate rolls of this from time to time and it is cut to size. This polythene is stiff enough for labels, titles, etc., to be brailled directly onto it.

An ordinary biro which has run out of ink, and which would normally be thrown away, makes an excellent “pencil,” and at little expense, you are ready to draw.

Two sets of apparatus are needed, one for the teacher and one for the pupil. The diagram is built up stage-by-stage with the teacher drawing a line, the student copying it, the teacher adding the next line, the student copying that, etc. This is labor intensive and time consuming, but is well worthwhile as it is an enormous help to concept formation as well as giving the student more complete access to the curriculum. It is important to keep it simple (KIS) as the eye loves detail, but the finger is confused by it. Diagrams, therefore need to be reduced to their bare essentials, and with beginners, a single line is often used in place of the normal double lines. As students become more competent, more detail can be included, more of the diagram can be drawn at each stage, and conventions like double lines observed.

INTEGRATED SCIENCE TOPIC—MEASUREMENT

This topic involves students in practical measurement of length, volume, time and temperature, and techniques and locally made/adapted apparatus have been devised for the first three of these.

(a) LENGTH: An ordinary wooden ruler, as used by most of the sighted students, was notched at 1 cm intervals using a razor blade. The blind student can now measure to
the nearest 0.5 cm—the same degree of accuracy as with the imported plastic rulers. A standard meter rule is turned into a tactile instrument by hammering cut-off pin heads at 1 cm intervals. This can be extended to having two pins at each 1 cm, one pin at each 0.5 cm and three pins at each 10 cm. Tape measures are readily available in the market. These can have holes punched at 1 cm (or 1 inch) intervals, like the imported ones, or, even better, have a staple fixed at each 1 cm mark.

(b) VOLUME: The above apparatus can be used to measure and calculate the volume of regular objects, but different techniques are needed for liquid volume and irregular objects. Now there are two methods of measuring liquid volume. The first is when the total volume of a liquid is measured; the second is when you wish to measure out a stated volume of a liquid. Both are possible to some extent for blind people. An imported light probe can be used to accurately determine the level of liquid in a measuring cylinder with tactile markings. But without a light probe an estimate can still be made. Graduated beakers of various sizes are marked by super gluing small pieces of gravel on the marks on the INSIDE then varnishing them with clear varnish. Using their fingers to determine the water level, and knowing the interval between each tactile mark, the blind student can make a very rough measurement of the volume of the water. This has a number of disadvantages in that it is far from accurate, and can only be used with harmless liquids like water, but it DOES convey the concept of the use of the measuring cylinder. In the same way a very rough measurement of the volume of irregular solids can be made by finding the volume of water, then adding the object and finding the new level. Again, far from accurate, but the concept is conveyed far better than by a mere description!

In place of a pipette for measuring out accurate amounts of liquid, a plastic syringe can be used. These can be imported ready notched or medical friends can be asked to save used syringes which are quickly and easily notched with a razor blade to enable the accurate measurement of various volumes. By using large and small syringes, accuracy of 0.1 cm$^3$ can be achieved (see “TITRATION” below). Blind students easily learn to use a “syringe-pipette” and are delighted to find that they can be as accurate as their sighted peers.

(c) TIME: Simply take an ordinary stop clock from the laboratory, remove the cover glass and super glue cut lengths of pin onto each second mark with longer lengths at the 5 second marks.

CHEMISTRY TOPIC—TITRATION
At first sight, titration with its reliance on seeing a color change in the indicator, and in the absence of a costly imported talking pH meter, might seem an impossibility for the blind Nigerian chemistry student. The solution was to use a “human talking pH meter” i.e., the teacher or a fellow student who, after each addition of acid made by the blind student, simply said “no change” or “change.” One could argue that as the blind student does not have to determine the end point for himself, the experiment is easier for him; but it can equally be argued that the problems his blindness cause in accurately carrying out the rest of the titration techniques are an “equal-but-opposite” disadvantage and thus even things up! Certainly, it is better for the blind student to perform this modified titration than to simply work with other people’s results.

A plastic beaker, labeled with a braille “A” is used for the acid and a glass beaker labeled with a braille “B” for the base. Using a large “syringe pipette” the stated volume of base is measured into conical flasks and indicator added in the usual way. The rough titration is made by adding acid 0.1 cm$^3$ at a time from a large pipette notched at 0.1 cm$^3$ intervals. When the “human talking pH meter” says “change,” the total volume added is noted. A volume of acid which is 0.1 cm$^3$ less than this amount is then added to the second flask. The blind student then changes to a 0.1 cm$^3$ “syringe pipette” which is notched at 0.1 cm$^3$ intervals, and adds 0.1 cm$^3$ at a time until the “human talking pH meter” says “change,” when the total volume is again noted. This is repeated until good replicates are achieved. An experienced blind chemistry student using this technique can achieve results every bit as good as the best of his/her sighted peers.

CONCLUSION
With ingenuity, a little money and much time, blind students of science subjects can be given nearly full access to the practical and diagrammatic aspects of science syllabi, improving their understanding of the subject, and thus enhancing their chances of success in examinations and their quality of education and hence of life.

Remember!!

Manuscripts may be submitted directly to the Section Editors.
REVITALIZING TEACHER PREPARATION IN SCIENCE
Lynn W. Glass, Russell Aiuto, Hans O. Andersen

The Path to Reform
Deans of Education, Deans of Arts & Science, and science educators representing nearly 20 of America's leading scientific organizations met in September of 1992 to address the question: Are we preparing teachers who are able to teach the new reform curricula?

An Agenda for Action
Major science curriculum reform presently is being influenced by several professional associations. The National Science Teachers Association is guiding the development of Project Scope, Sequence, and Coordination, and the American Association for the Advancement of Science is guiding the development of Project 2061. Both projects share several common characteristics. First, common science themes, developed by the American Association for the Advancement of Science, are used to organize the content in the curriculum projects of both Associations. Second, the projects of both Associations share the following characteristics:

- Sequenced instruction to corroborate intellectual development patterns exhibited by children.
- Integrated or coordinated curriculum activities from biology, chemistry, Earth/space science, and physics to support connections among these four areas of science.
- Spaced instruction using a spiral approach to permit students to build upon prior experiences and concepts, each time on a level of greater breadth and depth.
- Developmentally appropriate hands-on and minds-on curriculum to provide science instruction every day for all K-12 students.

Each of these characteristics is supported by research and is demonstrated in practice. Project Scope, Sequence, and Coordination and Project 2061 are unique in that no other science projects have incorporated all four characteristics into a single model for science instruction in the United States, although many foreign countries have adopted these characteristics into their science curricula.

Making science accessible and scientific literacy attainable for all students is a national need. If we are going to enter the 21st century as a world leader, our populace must be able to function in a scientific and technological society. We must also be responsive to the cultural, ethnic, social, and gender differences that are present in our society; and special efforts must be made to enfranchise minorities, females, and other groups traditionally unsuccessful in entering the scientific pipeline.

Considerable evidence exists on how we learn science. Students must be provided with developmentally appropriate opportunities to investigate, to explore, and to construct meaning for themselves. We need to use student-centered teaching strategies focused on a few major and powerful interdisciplinary ideas such as those presented in Science for All Americans. This is in contrast to our present orientation of teacher-centered instruction and the superficiality of concept coverage that is too broad.

Change in American K-12 education is a shared responsibility. In the last decades, grass-roots efforts have been building a new vision of science education for all Americans. Setting goals, developing strategies to achieve our goals, and carrying out the tasks needed to become the strongest scientific nation in the world are responsibilities we all share—government, the private sector, and elementary-secondary-collegiate education.

Because universities are among the agencies that share in the responsibility to bring about change, university presidents must dedicate senior, high-profile faculty in the sciences and education to the task of building programs that develop scientific literacy at all levels of instruction. University faculties must work as team members with elementary-middle-secondary teachers as well as with their university-level peers to bring about the changes. Reward structures, work assignments, and professional expectations must be changed to encourage and to reward individual and team efforts. Universities, as well as K-12 schools, need to use the strengths of the interactive technologies in developing and delivering programs to successfully improve the education of the youth of America.

The projected growth in the use of Project Scope, Sequence, and Coordination, Project 2061, and other interdisciplinary approaches to science teaching will necessitate the identification of effective models of preservice teacher preparation or the creation of new
models. Among the influential groups that can affect the
development of new models are the Holmes Group, the
Carnegie Commission, Project 30, and the Renaissance
Group. From the writings of these groups, six principles
can be identified to guide the development of exemplary
preservice science preparation models.

These six guiding principles are intended to focus on three
aspects of a comprehensive program—content/process
preparation, pedagogy, and the nature of human
development and learning. Thoughtful teacher education
efforts must focus on the intersections of these three areas
of expertise, we must also understand the interrelatedness
of these components. Each is affected by and in turn
affects a larger context or milieu, including, but not limited
to, issues of gender, social, and ethnic equity; reward
structures; ethics in science and science teaching; student,
classroom, laboratory, materials, and equipment
management; and scholarship expectations. It is not the
intention of this paper to suggest that these and other aspects
of a comprehensive preservice program are less important
or in less need of reform. Rather, it is to focus our efforts on
areas where the nation’s scientific research universities are
most capable of providing assistance. Too often our
efforts are concentrated on only one of these components
in preparing teachers, or, at best, the intersection between
two of them. These six guiding principles are meant to
emphasize the importance of how all three domains must
form the heart of the teacher preparation program.

A growing number of science teachers entering our
profession choose teaching as either a second career or as a
change in academic emphasis late in undergraduate
preparation. The six guiding principles proposed in this
paper can serve as points to begin the discussion on how
to best to prepare nontraditional students to meet the needs of
the 21st century classroom.

Guiding Principle One

Every elementary-middle-secondary science education
preservice student should experience the investigative
nature of science. Humans are natural investigators who
tend to lose that capacity due to a lack of opportunity to
use it. George Gaylord Simpson defined science as a
natural human investigative endeavor in which we
question, seek explanations to our questions, and test our
explanations. Although didactic teaching has its place, it
cannot impart an understanding of the investigative nature
of science, but direct investigative activities can. Hence,
all classes in the sciences and in the teaching of science
need to reflect the investigative nature of science in spirit
and substance. All teacher candidates—elementary,
middle, and secondary—should participate in at least one
open-ended investigation carried out over an extended
period of time. This experience should culminate in the
preparation and presentation of an appropriate scientific
report.

The most effective investigative experiences begin with
questions and problems that are generated by the students.
Like scientists and other professionals who generate their
own questions, preservice experiences should emphasize
this capacity to enhance lifelong learning. In addition,
students must be given opportunities to collaborate with
others—as scientists do—and to develop team work habits.
Opportunities for collaborative problem-solving are
numerous on major research campuses. In the various
research programs, students can be mentored in problems
of their choosing on such topics as scientific and
technological research, investigations of the nature of
learning science, and inquiry into the history and
philosophy of science.

Guiding Principle Two

Every elementary-middle-secondary science education
preservice student should have classroom and
laboratory experiences in biology, chemistry, Earth/
space science, and physics. It is desirable that all
precollege teacher candidates achieve competence in
science equivalent to at least a major that reflects depth in
one discipline and breadth across a spectrum of science
areas. It is recommended that half of the time a student
devotes to the study of science be concentrated on a single
discipline while the other half be divided among the
remaining disciplines.

Science at the collegiate level should reflect what is known
about how understanding and meaning is acquired in the
natural sciences. Students must have opportunities to
construct meaning from activities and courses which focus
on relatively few but powerful topics. Courses must be
designed to help all students acquire science literacy.
Special laboratory or discussion sessions that focus on
issues and problems relevant to the needs of students
enrolled in education, engineering, the humanities, the arts,
etc., should be developed. These new courses will form
the core of scientific understanding for college graduates,
and additional depth and breadth will be developed from
existing courses for majors in the specific sciences.

Guiding Principle Three

All elementary-middle-secondary science education
preservice students should understand the
interrelatedness of science disciplines and the
connections between science and other areas of
knowledge. Solving problems that are rooted in the
scientific and technological arena draws upon skills and in
the scientific knowledge that is multidisciplinary. Special
efforts must be made to assist students in understanding
the connections among areas of science and to recognize that efforts to learn natural science, social science, mathematics, philosophy, and literature complement each other. Team teaching with experts in other subject areas and specially designed courses are ways to accomplish this.

Guiding Principle Four

All elementary-middle-secondary science education preservice students should learn scientific content and thinking processes in the context of contemporary, relevant, personal and societal issues and problems. To be useful in decision making, the thinking processes and knowledge learned in the classroom and laboratory must have application to the real world. To accomplish this goal, curricula must be reconstructed and instructional strategies modified so that preservice candidates are able to think critically about integrating scientific-technical and social issues.

Guiding Principle Five

All elementary-middle-secondary science education preservice students must have a sound understanding of the nature of learning and how it can be applied to the learning of science. This understanding includes two important ideas: that science knowledge (content) and skills (processes) are through direct, appropriate experiences that have relevance to the learner; and that capacities related to learning are developmental and sequential within each student throughout the grade levels. Thus, content and activities must be selected to be appropriate and ordered to be cumulative over time. Currently, schooling provides an eclectic selection of science experiences throughout the grades. Such experiences are often presented to students at a time inappropriate to their capacity to comprehend the topic. Such experiences are often redundant (e.g., the topic of photosynthesis)—repeated at several grade levels without adding anything new. Such experiences are seldom conceptualized to contribute and link to more advanced understandings. It is through a sound understanding of learning and science that collaboration can take place among teachers at all the grade levels so that science frameworks and science experiences truly exemplify a hands-on, minds-on, science curriculum.

Guiding Principle Six

All elementary-middle-secondary science education preservice students should have several intense and extended clinical teaching experiences at a variety of Grade levels in diverse socio-economic and cultural settings. Each experience should be grounded in theory and pedagogical knowledge. These experiences should provide students with opportunities to demonstrate their teaching of the subject matter in an environment where they receive regular and systematic feedback from practicing science education is good teacher education.” master teachers, professors of science, and science educators. We have long known that our students tend to model the various ways in which they have been taught; hence, good science education is good teacher education. One way to change education in America significantly is to break the self-duplicating cycle of poor teaching at the point of undergraduate instruction in the sciences and education. Designing college courses to reflect the different learning styles of students and to incorporate higher-order questioning, cooperative learning, and problem-solving strategies will require intense and lively cooperation between faculties in education and the arts and sciences. With this capstone undergraduate experience the science teachers of tomorrow will be better able to meet the scientific and technological demands of the 21st century work force.

References

A father and mother approached me at the conclusion of one of our Celebrations of Learning with the following comments. “We just wanted to thank you for all your help in preparing our son to be a great teacher. Today was the first time in over 10 years of paying college tuition for our three children, that we have seen a real result or outcome. We can not believe how much growth our son was able to show, how many skills he now possesses and how clearly he stated his future goals.”

These parents had just attended a ninety minute exit presentation to an audience that is many times composed of the instructor, other class mates, family members, significant others, (spouse and/or friends), the student’s cooperating teacher, and others as invited by the student. This last category has included professors (from both Arts and Science and Teachers College), and present, part-time employers of the presenter. In addition, open invitations are sent to incoming methods students and the cooperating teacher that the methods student will have the following semester during his or her student teaching.

An Overview
In preparation for this presentation, students have taken at least one methods course, a science curriculum class, and had at least two separate semester-long practicums. All of this is synthesized as the student constructs a portfolio that is revised throughout their career. The portfolio contains at least four general categories and serves as the overlying structure for the final presentation: (a) a discussion of the teachers’ rationale for teaching, (b) samples of products, (c) evidence of growth, and (d) a clear plan for future growth and development.

The Presentation
The actual presentation takes place during finals week, although large classes have used part of the previous week as well. A sign up schedule with all possible open dates and times is posted soon after mid-term and is full within a few hours. Because of scheduling concerns, evening slots are also made available. This many times is the only way to get cooperating teachers free to attend.

At least one week before the presentation, each student must submit a complete lesson plan for the presentation and a guest list. The presentation must employ the skills of the pre-service teacher and be based on sound educational research theory. Many of the presentation plans have been built around the learning cycle and use such strategies as cooperative groups, activities, computer assisted instruction, as well as large group presentation skills. The key objectives for this time is to provide an overview of all four components of their portfolio while demonstrating appropriate teacher behaviors.

Students have also shown segments of pre-post video tapes, examples of products using multimedia including hypercard stacks, quick-time clips, scanned student products and had the audience (class) help critique growth.

Setting the Stage
From the very beginning of the semester, students are working on their portfolio. Table 1 represents a brief project description that is given to these pre-service teachers as part of their first methods course syllabus.

Table 1.
On the Road to the Celebration of Learning
A portfolio is a systematic, well organized collection of evidence used to monitor the growth of a student’s knowledge, process skills, and attitudes (Bonnstetter, 1992). Your portfolio will contain:

1. A well thought out and research supported Rationale for Teaching that describes your present vision and beliefs of teaching and learning.
2. Products from the Semester such as lesson plans, bulletin boards, exams, student projects, student evaluations, video tapes showing you working with large groups, small groups, and with individuals. Each of the tapes should be coded for teacher behaviors and critiqued in writing.
3. Evidence of Growth during the semester and/or career make up the third criteria. Examples include pre-post video tapes, revised products showing various stages of
understanding including lesson plans, assessment
instruments, student and teacher assessments and/or
journal entries capturing different stages of
understanding.
4. A Plan for Future Growth represents the final portfolio
section. This establishes a path or set of goals for
continued professional development.

Your portfolio is an organized and selective collection of
evidence that documents what you know and what you
know how to do in the teaching of science. Each section
should consist of documents and/or products which are
authentic evidence of your understandings or abilities as
well as evidence of growth.

Your portfolio must be developed over time, therefore it
will be a dynamic form of assessment that will be drafted,
revised, and updated constantly. In other words, be
prepared to add, replace, delete, and reorganize both your
goals and evidence as you move through the remainder of
your teacher preparation program.

Your portfolio is rationale-based. It is important for
someone reviewing your portfolio to clearly see your
vision of teaching science and that you are able to defend
this vision with a sound research-supported base of
knowledge. In addition to your rationale for teaching
section, a statement of your three or four most important
goals in each of the remaining sections will help introduce
and focus the reader to see the connection between your
goals and the evidence supplied.

Your portfolio is selective. From all the possible
documentation at your disposal, you must choose those
items that best demonstrate what you have accomplished
or how you are moving to accomplish a particular goal.
This is yet another good example of where the “right”
choices confirm the “less is more” statement.

Your portfolio is reflective. It is extremely important for
you to prepare short captions that either precede individual
pieces of evidence or are attached in some manner to
explain to the reader why this evidence has been included
and what it shows about your understanding of teaching or
your teaching abilities. This process will transform “stuff”
from meaningful evidence that portrays you as an
emerging teacher.

Your portfolio is collaborative. While you have the
ultimate responsibility for developing a portfolio that
documents your professional growth and development, you
need to remember that teacher preparation is not a
competition. You should consult colleagues for advice and
feedback as you collect and select evidence and make
decisions concerning presentation format. With the
growing role of technology, the use of hypercard stacks
and quick-time clips should be considered.

Your portfolio might include:
1. An introduction containing your rationale for teaching
but starting with three or four overall goals statements
and the advanced organizer for the reviewer about your
document. The “rationale for teaching” document itself
will take considerable time as you first draft thoughts
and then boil them down to a concise five or six page
statement. The rationale should provide insights into,
for example, your understanding concerning: (a) why
you will teach science, (b) what your goals for science
students are, (c) how you will decide what content to
provide, (d) what your curriculum will look like,
(e) what you would like students to be doing in the
classroom, (f) what you will be doing in the classroom,
and (g) how you will provide evaluation of your
program. Some of these sections will need
research-base documentation to both explain and justify
your vision.
2. A table of contents listing how you have organized your
evidence sections and what they include.
3. All items you have selected to document your
professional understanding and continued development.
4. Captions for individual documents that label, describe,
and focus the reader toward your intended purpose for
including this evidence. Captions should be brief, to
the point, and clear; they should tell the reader what the
document is, where it comes from, and what it suggests
about you.

Even though the primary audience for the portfolio is you,
the developing teacher, and your instructor, remember the
other potential readers and their needs. These additional
audiences might include cooperating teachers, school
district recruiters, colleagues, and other university
instructors. You may not be standing by for oral
explanations, so design your portfolio to clearly speak for
you and about you.

Final Thoughts Before Starting
Before any trip can begin, you must know where you are
going. During the first week of this class, course goals
will be reviewed and revised based on specific needs
identified by you and other classmates. These goals will
serve as the initial criteria for which you should start the
collection of evidence concerning your understanding of
science teaching and your professional growth to that end.
Therefore, to begin building your portfolio:
1. Clearly state a set of goals for professional development. In other words, list what you hope to accomplish this semester and throughout the rest of your teacher preparation program.
2. Create a personal list of course requirements in a format that makes sense to you and contains specific check points in terms of degree of completion with calendar dates.
3. Create a collection of documentation you already have, you will have, or you could develop that will demonstrate that you have met or are working toward each of the specific goals for professional development you have established.

This portfolio project description was developed after a review of the literature and with assistance from English Teacher Educator, Dr. David Wilson, who shared his syllabus containing the English Methods “ELATEP Portfolio Project.” In addition, ideas have been taken and adopted from Dr. Linda Vavrus’s classroom handout, “Guidelines for Developing a Portfolio to Showcase Professional Growth and Learning.”

The Developmental Phase
With the above guidelines for portfolio development in place, the methods sequence begins. Without going into another complete article describing the rather unique course itself, it may suffice to say that during the class, students are confronted with major paradigm shifts, the latest science and general education reform literature, and numerous opportunities to practice and refine their teaching skills and understandings. Examples of other learning opportunities that occur before student teaching include:

**Bulletin Board or Interactive Display.** Each class member is responsible for providing our Science Education Center with one or more Bulletin Boards or interactive displays. Students as a group define the characteristics of a quality display, and create their display, and evaluate their own as well as one other based on the agreed upon criteria. Pictures are taken for possible portfolio inclusion.

**Journal Article Review.** Students use the following 3R outline to describe their response to and analysis of one article dealing with the teaching of science. The 3R response format is divided into three categories: Reaction, Relevance, and Responsibility. These categories closely resemble Bloom’s Taxonomy of the domains of learning—the cognitive, the affective, and the psychomotor. The difference between the two nomenclatures is that the 3R Reaction scheme deals with the reaction of the affective domain first, rather than the cognitive. The rationale for the difference in placement is so the student can become aware of their affective response, and then deal with the cognitive merit of the learning regardless of the positive or negative affect associated with it. The 3R response format is also used by students as they make daily journal entries. When writing a 3R Reaction the following guidelines should be followed:

1. Reaction (Affective Domain, To Feel). What was the reader’s response (favorable, unfavorable, or mixed)? Give at least one example from the experience to support the point.
2. Relevance (Cognitive Domain, To Think). How pertinent is the event to the issue-at-hand (the conceptual framework of the event). The reader should be able to recognize and discuss how specific or important (meaningful) the event is to the course or issue and give at least one example from the reading to support the print.
3. Responsibility (Psychomotor Domain, To Do). How will the knowledge gained from the event be used in the everyday life of the reader? Give at least one example of possible application in your personal or professional life.

**Pre-Course Teaching Experience.** During the first week and again at the end of the semester students teach a ten minute lesson during class time. “You are to teach a topic of your choosing, based on what you know about teaching, and include a discussion within your lesson.” A lesson plan is also to accompany each presentation. Both lessons are videotaped and coded for teacher behaviors, interaction patterns and questioning strategy development.

**Fourth and Fifth Grade Teaching Experience.** Students prepare an activity, including a lesson plan for third through fifth grade gifted students. Each lesson is presented to our class and eight activities are revised for presentation in a nearby school. Only eight activities are presented to accommodate the school’s eight period schedule and to allow manageable class sizes for these neophyte teachers. This activity requires a full day and occurs approximately six weeks into the semester.

**Curriculum Project.** First students prepare a working definition of curriculum and then describe the components of their curriculum for a particular course of their choosing. The purpose of this activity is for students to become extremely familiar with a curriculum project, or a textbook series.

**Professional Involvement.** Each student is required to document a minimum of eight hours of professional involvement. Examples include Science Education monthly club meetings, and/or local, state, regional or national professional conventions. At least two of these hours should be volunteer work such as: science fair judging, Saturday science programs, Children’s Museum, or assisting with an inservice presentation. Documentation should include a complete description of activities plus personal perceptions as to the value of the experience. All of this material may have a place in the portfolio.
Unit Lesson Plan. (This experience is to be tied to the practicum.) Students are to develop a topic into a unit of lessons that will run approximately 15 class days. The unit plan should include at least the following: (a) general goals, (b) objectives/outcomes for the unit, (c) major activities or components of the unit, (d) rationale for this topic, (e) materials needed (include cost and source), and (f) list of hazards and safety considerations.

In addition, daily lesson plans must be developed that include at least the following:
1. Specific lesson objectives/outcomes.
3. A breakdown of components for each lesson with a time estimate.
4. Teacher behaviors predicted.
5. Student behaviors predicted.
6. Evaluation: (a) of student (included copies of assessments, portfolios, etc., and (b) of teacher.
7. Other items: (a) teacher questions that might be asked, (b) where the activity might lead (also extension activities), (c) how this might mesh with other topics in and out of science, and (d) space for teacher comments upon lesson completion.

Class Participation/Daily Assignments. There are numerous daily assignments. Much of the class time is spent in small group and large group discussions of reading assignments. Students are requested to prepare questions and/or comments over readings before these readings are discussed.

Inquiry Based Science Demonstration. Each class member prepares a three to five minute, teacher-centered demonstration, including a lesson plan handout for all class members. The presentation must model appropriate inquiry based teaching strategies. Portfolio entry should also be considered.

Weekly Journal Entries. This is an opportunity for students to "reflect" on their personal feelings and concerns toward teaching, as their philosophy emerges. A minimum of a half page entry per week is required and daily entries are required during special activities. Journal entries are electronically sent to the instructor at least once each week. All students are given a computer with modem at the beginning of the methods course and if necessary, they may keep the unit until the fall following graduation. The student computer loan program is composed of old IBM model XT's which have been donated by local businesses and other University departments as updated equipment is purchased.

Practicum Experiences. Each student will have had two practicum experiences at the completion of his or her methods and curriculum sequence. The first will entail a minimum of 40 hours of volunteer teaching in an informal setting. The second experience will require at least two periods everyday for 10 weeks. A list of recommended experiences for the formal practicum include:

1. Learn all students' names within the first two days,
2. Write and share observations of class sessions and particular students in assigned classes.
3. Assist with: taking roll, reading bulletins, handing out papers, and setting up and breaking down laboratory experiments.
4. Grade student papers.
5. Be familiar with school policies and procedures.
6. Create a bulletin board and/or window display.
7. Be involved with students in one-on-one and small group settings.
8. Observe one student over the semester and regularly log records on behaviors, interactions, class performance, physical changes, emotional reactions, and special needs.
9. Make explicit lesson plans based on student needs.
10. Teach as many lessons or portions of lessons as possible.
11. Plan and teach at least one topic area or complete unit as described in more detail in the major activity session.
12. Take time to reflect on experiences as a "Teacher Assistant."
13. Experience Team Teaching, not just turn teaching.
14. Demonstrate the use of checks for understanding.
15. Follow one student for as much of an entire school day and document and react to your findings.
16. Send reflections and reactions electronically to the university instructor, and other classmates when appropriate, at least once each week.
17. Administer an instrument to assess student perceptions concerning your interactions and teaching.

The Assessment Process
The cry nationwide concerning portfolios and presentations is focused on "how do we assess them." The first step is to rethink our traditional view of grading and assessing. Once this has been accomplished and an understanding of summative and formative assessment developed, we will look back and wonder how we ever justified our antiquated letter and grade point approaches. But as an intermediate step, the following generic grade rubric may serve as a guide. Each semester this rubric is redefined by the class to best serve their developmental needs (see Table 2).

You also may notice that the rubric applies only to the course outcomes as a summative assessment. The portfolio has no assessment rubric and is handled as a formative course component.
Table 2: Science Education Grade Rubric

A—In addition to carefully completing all course goals and fully participating in all discussions and field experiences, an “A” in the methods block indicates that a student is extremely well-qualified in terms of teaching skills and possesses the ability to be outstanding during student teaching. This student displays quality planning, interacts well with students, shows command of subject matter and has ability to discuss a number of issues in science education. This student shows creative flair as well as a strong commitment to education. This individual is well on the way to becoming a formal operational teacher. Furthermore, all of the above criteria have been systematically documented and presented in his or her portfolio and during the Celebration of Learning.

B, B+-In addition to completing all assignments and participating in all field experiences, a “B or B+” indicates that this student possesses ability to plan, interact and deal with issues in science education. This individual understands the subject matter and can implement effective lessons. Both the portfolio and the celebration of learning indicate areas of need that the student has identified and established a plan of action to correct.

C—This person possesses the basic competencies deemed necessary for science teaching. It is assumed that all course goals have been completed. This student may be quite successful in some areas and not so successful in others. A “C+” student may need special attention during student teaching to insure success and certification. The portfolio and the celebration of learning presentation should indicate areas of need but the student may not have developed a well thought out plan of action for further professional development.

C—A “C” grade indicates that the student is unsuccessful with the basic competencies even though this individual can direct a classroom given support and directions. This student may have achieved many of the course goals, but does not possess the basic competencies necessary to student teach. The portfolio and the celebration of learning presentation will show areas of accomplishment and how these skills will be redirected toward another career choice or how the student will back up and correct these deficiencies before being allowed to continue into student teaching.

D, F—Complete failure early in the term will signal a grade of “D or F.” This individual will be counseled to drop the class and redirect their professional goals based on individual strengths.

This Rubric was originally created by Dr. John E. Penick and has been modified to serve as a sample for each new class to rework.

Summary
Many of the students upon first examination of the course syllabus and goals immediately understand why the final is called a Celebration of Learning. As one student recently said, “Anyone who lives through this deserves to have a celebration.” But just as the course syllabus ends with the following statement, we as educators of educators must also remember, that “The love of learning is taught, not taught.” Portfolios provide the best option yet for each of us to catch a life-long love of learning. What about scheduling yourself for a portfolio presentation along with your students next semester?

Credits
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References


THE INTERNATIONAL ASSOCIATION OF SCIENCE CLUBS

As a prelude to upcoming section articles this issue expands on the role of the International Association of Science Clubs as depicted in the feature article.

I.A.S.C.'s official aims include: 'Education' and the 'Fostering of International Friendships.' Others are 'Service to one's Community, and learning Social Responsibility,' and 'Making Provision for Jobs through Work Places in Science Clubs.'

This section focuses on the interface between non-formal, informal, and more traditional formal science education. Articles expose the world of out-of-school and public science experiences.

(Left) Staff from the China Association for Science and Technology, Department of Children and Youth Affairs with I.A.S.C. Secretary B.J.K. Tricker on the Great Wall. The Chinese significance of a picture of the Great Wall is 'everlasting life,' and an appropriate sentiment for associations to exchange among themselves.

I.A.S.C. passes on this sentiment, wishing ICASE everlasting life as well!

(Right) I.A.S.C. Secretary Brian Tricker teaching a teenager to operate the gears on Saddocks Farm Science Club's 1948 Fordson Major. I.A.S.C. formed in 1982 through international interest in the Saddocks Club, and now, among other things, owns a small village in Scotland being modified into a small science centre.
Resources

ASIAN WORKSHOP ON GLOBAL CHANGE EDUCATION MATERIALS
A Report by Dr. Jack Holbrook
Executive Secretary, ICASE

The Education in Global Change project, developed by the International Council of Scientific Unions Committee for the Teaching of Science (ICSU CTS) is a result of a worldwide collaboration between science teachers and researchers in Global Change. A series of six interdisciplinary units have so far been developed, entitled:
- The Global Carbon Cycle
- Remote Sensing: Window on Global Change
- The Changing Atmosphere
- Oceans
- Clues from the Past: Glimpses of our Future
- Population and Land Use

The idea of the units is to show how science is a force for good and that scientists have a vital role in enhancing the quality of our lives. However to show this it is necessary to appreciate what advice scientists can give to decision makers, be able to judge the quality of that advice, and appreciate what effect the advice, if accepted, will have on us. It is important that students, once in possession of the relevant facts and parameters, are able to make up their own minds about issues and that teaching should be geared towards these goals.

The units can be used also as a means of introducing important scientific principles to students in the age range of 16-20. A good understanding of these principles is necessary for the understanding of the environmental issues such as the protection of the ozone layer, the increasing greenhouse effect, and the destruction of rain forests.

Each unit has been written as a series of student activities supported by notes for teachers. The units, or just simply single activities within a unit, have been designed to be used in existing science courses. They may also be adapted for use in general students and other programmes.

In summary each unit has been designed to:
- Cover key scientific concepts;
- Illustrate science in context of important environmental issues;
- Encourage student participation;
- Encourage skills such as data interpretation, decision making, communication; and
- Illustrate the positive role played by scientists in society.

BOOK REVIEW

Science Is . . .: A Source Book of Fascinating Facts, Projects, and Activities
Susan V. Bosak, Douglas A. Bosak, and Brian A. Puppa
New York: Scholastic

This review was written by Julie Thomas, Science Education, University of Nebraska-Lincoln.

Once in a while, a science resource book comes along which every teacher should have. Consider Science Is . . . a treasure whose time has come. This book is a must!

Eight years of grassroots research has gone into the development of this book. Educators, scientists, parents, and children have come together in workshops, focus groups, interviews, classroom observations, field tests, and a review of over 1000 other science resource activity books.

Coined a “hassle-free resource that works,” this very well organized text includes everything a teacher needs in one place—on one page. Best of all, it is clearly created for teachers. Practical, hands-on activities are carefully organized and include step-by-step, easy-to-follow directions. Explanatory information is included for those teachers with limited science background. Illustrations and cartoons help explain activities, and fun fact notes are scattered throughout the book.

To provide maximum flexibility, there are three types of activities included in the book. “Quickies” require no preparation and can be used to introduce concepts or fill a few minutes. “Make Time” activities require some preparation and a few inexpensive materials. “One Leads to Another” activities are designed for investigation in greater depth and connect in a series of longer activities that build on one another. The ten broad subject areas include: Discovering Science, Matter & Energy, Humans, The Environment, Rocks, Plants, Living Creatures, Weather, The Heavens, and Applying Science.

Science Is . . . would be ideal for enriching an elementary or middle school curriculum, provide attention-grabbing introduction to more complex material for high school, and would be a useful as recommended or required resource for science teaching methods students.

Science Is . . . has received strong reviews including the support of National Science Teachers Association and American Association for the Advancement of Science. Written by Susan V. Bosak, Science Is . . . (ISBN 0-590-74070-9) includes 515 pages and costs $29.95. It is available through the National Science Teachers Association (800 722 NSTA) or Scholastic (800-325-6149).
Profile

CARIBBEAN SCIENCE EDUCATION LOSES
A STALWART:
THE PASSING OF FLORENCE
COMMISSIONG
by Winston King

Florence Commissiong died in Jamaica on August 18, 1993. Flo, as she was affectionately known, was one of the foremost science educators in the Caribbean, as a classroom teacher and innovator since the late 1950s. I remember vividly the first time I met Flo in October, 1973. We were attending a UNESCO-CEDO Science Conference in Barbados. The Secretary-Treasurer of a newly-formed International Council of Associations for Science Education (ICASE), Dennis Chisman, was there. All participants were impressed by her quiet manner, which hid somewhat the great wealth of knowledge and experience that she possessed. She was frequently quiet but when she spoke people listened attentively.

Flo spearheaded the development of the Caribbean Examination Council Integrated Science (Double Award) Syllabus beginning in 1975. That development is acknowledged, even by critics, as one of the most progressive and insightful that the region has seen. She worked tirelessly as well on the UNESCO RLA-142 Science materials for science teachers, producing one of the best selling science textbooks for the 11-14 age range, Integrated Science for Caribbean Schools. She planned and implemented many regional and Association of Science Teachers of Jamaica (ASTJ) activities and served as Chief Examiner for CXC until her death. To the best of my knowledge she did not miss one year of setting, marking and grading exercises since 1979.

But I have so far only spoken about her extracurricular activities. Indeed, she also produced a sterling performance in her full time employment as Senior Lecturer in Science Education, University of the West Indies, Jamaica. Let me share with you the impressions of her given by one of her former Diploma in Education students from St. Lucia: “That white-haired lady is so strict and serious about her work. She is a perfectionist and works you hard. However, if I had to do it all over again, I would choose to work with her.” I know that all of us with whom she worked would share these sentiments.

Flo was honored by ICASE for outstanding work in local, regional, and international science education in 1985. She was also recently honored by a group in the USA for distinguished work. These are the honors and distinctions I know about, but I am sure there are many others. My fuzziness on this point is due to the fact that Flo’s humility, modesty and passion for excellence continued to make her a person not given to public announcement of what she had achieved.

Flo and I kept in contact to the end. A few weeks before her death her daughter called me to decline an invitation given to her mother to help me in a science workshop in Montserrat. This was not like Flo, so I called. I was devastated to realize that she was so ill. From thence we spoke frequently. Even as she grew weaker she would insist that my calls should be put through to her. One day she intimated that she was contented with her illness and was peacefully prepared to meet her maker. She lamented, however, that there were so many other things she wanted to do in science education. I assured her that whatever she did was very well done. I hope that she believed me because it was true.

There are very few persons who met Flo who would not have been touched by her decency, gentleness, loyalty, and commitment. These are the legacies she leaves behind to her sorrowing daughters, grandchildren and other relatives, and colleagues; as all of us who had the honor to know her.

HANDBOOK OF RESEARCH ON
SCIENCE TEACHING AND
LEARNING
Dorothy Gabel, Editor

Sponsored by the National Science Teachers Association

Handbook of Research on Science Teaching and Learning—$52.00

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Science Education International is the Quarterly Journal of the International Council of Associations for Science Education. ICASE was established in 1973 to extend and improve education in science for all children and youth by assisting member associations throughout the world.

This journal provides a means for associations, institutions, centres, foundations, companies and individuals concerned with science education, to share perspectives, concerns, ideas, and information which will foster cooperative efforts to improve science education, and which will serve as a chronicle of the advancement of science education throughout the world.

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ICASE News
Address of ICASE Secretariat 2
ICASE Welcomes New Member 2
Greece-Cyprus Science Teachers Annual Meeting 4
Project 2000+ Steering Committee Meeting 5

Coming Events
European Symposium in La Villette 6

Feature Article
Teaching Science for Social Responsibility 8

Science Education Around the World
Bolivian Reform Efforts: A Status Report 11
Science Education at the Basic Level in Trinidad and Tobago 13

Research on Curriculum,
Teaching & Learning
Using Minds-on Scientific Discrepant Events 17

Teaching Materials & Strategies
In-Service and Initial Training of Primary Teachers: A Flexible Response 21

Science Teacher Education & Leadership
The Lesotho Induction Programme 23

Non-formal & Informal Science Education
Informal Science Teacher Preparation 28

Assessment and Evaluation Trends
The Learner-Centered Principles 35

Resources 37
Calendar 40

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ICASE WELCOMES NEW MEMBERS

CYPRUS CHEMISTRY ASSOCIATION

This newest member of our family of organizations has goals that include:

1. to promote the subject of chemistry at all levels of education,

2. to discuss and help improve the school curriculum, as well as the present textbooks in use,

3. to focus attention on the problems related to teaching high school chemistry,

4. Organise discussions and lectures on chemistry,

5. to encourage professional development by providing educational articles in the Chemistry Magazine published by the Pancyprian Union of Chemists,

6. Co-sponsor a chemistry conference every other year between Greek and cypriot chemists. (This year the conference will take place in Greece this September.)

7. Organize the Pancyprian Chemistry Olympiad which takes place every other year. (Selected students from this event represent Cyprus in the World Chemistry Olympiad. This years the World Olympiad will take place in Norway.)

ICASE members might be interested in knowing that Cyprus chemistry is taught for a total of five years. For more information please contact Vice President, Helen Papachristodoulou, 3 Philopimenos, 241 Limassol, Cyprus

ESSEX-MALAWI LINK

by Jane Giffould

For the last year ASE Essex Section has been having a link with STAM in Malawi. STAM has just been reviving itself from a long hibernation to become a very active organization. In Essex we appreciate the benefits of a Science Teachers Association and so have been encouraging Malawi in their efforts. This encouragement has been active in that we have hosted teachers from Malawi, have made book and monetary collections for Malawi and most recently have attended their conference courtesy of SEDW.

This STAM first annual conference was successful with many teachers participating and hopefully gaining plenty. It was impressive in that it had cross-curricular themes being in conjunction with MAM, the Maths Association. It also had an international flavour with input from both Essex Section and Kings College, London.

As part of the conference, Essex was invited to the national committee meeting in order to discuss the direction of the link for the next year. This was very
much a two way process which included Essex getting tips on how to hold Science Fairs. Hopefully Essex will be able to follow up the suggestions made for the help that they can give to STAM.

Overall we were impressed by the effort that STAM has made to become an interactive organization which takes consideration of what its members need. We note that they are outgoing in their fundraising rather than sitting back and waiting for things to happen. We look forward to the development of STAM and are proud to be associated with them.

This link between two organizations on different continents is important in the development of teachers to give a far wider view of education. We know that there are international bodies such as ICASE however we also appreciate the more individual personal attention of the link. We would recommend such a procedure to other countries.

Photographs from the conference

The author in discussion with a participant

Making model lungs out of local materials
VIETNAM SOIL ECOLOGY SOCIETY

Dr. Vũ Quang Manh

Center for Biodiversity Resources
Education and Development (CEBRED)
Hanoi National Pedagogic University I

I am very pleased to inform you that the 1st Congress of the Vietnam Soil Ecology Society (VNSES) has taken place in Hanoi, at 31.3.1994. The organisation is national, scientific, and non-government body.

The member of the VNSES are, mainly researchers, educators, teachers, policy-makers, administrators, as well as those working on an interested in the field of soil ecology, and concerned ones.

The main aims of the VNSES are to unite all above-mentioned persons and organisations; to improve their studies, their evaluations and proposals to appropriate authorities in the fields of management of biodiversity resources, of soil and soil fertility, of environment; to enlarge education and training; as well as to develop scientific relations and cooperations at national, regional and international levels.

The VNSES Executive Board consists of 10 members, by election of the Congress, working for a five year period (1994-1998).

Professor Dr. Vũ Van Tuyen is elected as Chairman, and Dr. Vũ Quang Manh is elected as General Secretary of the VNSES. The VNSES has only occasional journal, with editors of Vũ Quang Manh and Vũ Van Tuyen.

On behalf of the VNSES Executive Board I would like to ask you for full membership of the ICASE, and to express our respect and trust to you and to ICASE Executive Board.

GREECE-CYPRUS SCIENCE TEACHERS ANNUAL MEETING

The 5th annual meeting of science teachers from Greece and Cyprus took place from 18-20th March at the University of Cyprus in Nicosia. The meeting was held in Greek and all abstracts appeared in Greek in the conference programme. Over 200 participants took part and presentations were made in two parallel sessions covering teaching and curriculum concerns in the two countries. Further details can be obtained from the Science Association for Cyprus, P.O. Box 4863, Nicosia, Cyprus. The Corresponding member is Christos Neocleus.

Greece-Cyprus Science Teachers annual meeting March 18-20, 1994, University of Cyprus. The ICASE Executive Secretary with members of the Science Association of Cyprus Committee.
PROJECT 2000+ STEERING COMMITTEE MEETING

The international steering committee for Project 2000+, chaired by Colin Power, Assistant Director General for Education, UNESCO, met 9-10th February 1994 at the Commonwealth Secretariat, London. ICASE was represented by Jack Holbrook, the Executive Secretary and Sheila Haggis, an ICASE award holder. Dennis Chisman, ICASE treasurer, was also present as an observer.

Decisions were made to publicise Project 2000+ by printing brochures and to prepare a 10-12 page summary that could be sent to Ministers of Education and International agencies. Partners agreed to try to publicise Project 2000+ further at conferences around the world.

The steering committee reiterated the need for National Task Forces (NTF’s) to be created. These should not be seen as the end product, but as a means to an end—to enhance STL through initiating national projects. The work of the NTF’s was seen as:

- being in charge of carrying out a needs analysis (as necessary)
- being in contact with relevant institutions and organisations, funding agencies, industry, etc.

- ensuring strong links with the EFA (education for all) group within the country (if it exists)
- seeking sources of funding for projects
- receiving and developing project ideas and seeking funds, taking note of the broader development needs of the country.

UNESCO agreed that they would prepare a document on what is meant by an NTF as there was still confusion as to who should be setting these up and what functions they should perform. It was stressed that the NTF’s need not conform to any set structure and should be created with respect to the national situation so as to enable them to function effectively.

It was expected that Governments would take the lead and have membership of the NTF, but science teachers associations and other non-Governmental organisations would be expected to play vital roles and perhaps be the impetus to get things going.

The steering committee agreed that a newsletter was essential and that this should emanate from the international secretariat at UNESCO.

No firm decision was possible on what to do with the material collected for the 1993 international forum, but the steering committee is preparing to produce a number of monographs for which these materials would form the base. Suggestions from NGO’s are welcome.

ASE annual meeting, University of Birmingham, UK, January 6-8, 1994
These ICASE executive members present at the meeting. Left to right: Sue Dale Tunnicliffe, Anna Garner, Dennis Chisman

Science Education International, Vol. 5, No. 2 June 1994
Coming Events

EUROPEAN SYMPOSIUM IN
LAVILLETTE

Alicja Wojtyna-Jodko
ICASE
European Representative

European symposium on “Science and technology teacher training: what training for what type of teaching?” was held from March 30th to April 1st, 1994 in the City of Science and Industry La Villette in Paris.

This symposium, which is the part of the project “A secondary education for Europe” was jointly organised by the Council of Europe, the French Ministry of Education and the City of Science and Industry (Cité des Sciences et de l’Industrie) La Villette. It was mainly for specialists in education, e.g., trainers, researchers, administrators, inspectors from 38 signatory state of the European Cultural Convention of the Council of Europe.

The symposium was under the patronage of Mr. Francois Bayrou, French Minister of Education and Mr. Francois Fillon, French Minister of Higher Education and Research.

Program of the three days long symposium included plenary sessions, round table discussions and working groups.

Participants had also possibility of visiting La Villette’s expositions.

Each day of the symposium’s debate was focused on different problems:

1. Training policy of teachers in science and technology:
   - What are the training structures and systems for secondary education teachers in science and technology in Europe?
   - How are secondary teachers trained and recruited in Europe?

2. Disciplinary training, interdisciplinarity and culture:
   - How are the disciplinary sectors structured?
   - What links exist between the different disciplines?

3. Teacher training and the way of use resources:
   - Scientific and development knowledge is done out-of-school: University, industry and research work together: the broadcasting of this knowledge does not only belong to schools, museums, media, scientific organisations also participate in it.
   - What are the links between the school and its different structures?
   - How do these resources integrate into the system of teacher training?

These and many other problems were discussed during symposium.

People representing almost 40 European countries presented what are the answers given in their countries for questions mentioned above.

Summarising shortly the main outcomes of this symposium it is necessary to state that it would be impossible task to run through the specificities of every country since there are even variations within one and the same country.

I would like to quote a sentence expressed in the first round table discussion: “Any teaching system cannot rise above the average level of its teachers.”

That is why it is so important to deal with problems of teacher education.

General agreement seems to have been reached on the fact that in all countries there are the same kinds of problems which may be summarised as: having to make the level of average teacher high enough to fulfill the needs of the individual in the society.

There is no doubt that to live successfully in modern society everybody needs a sound basic scientific and technological knowledge.

It was also clear that although problems are very similar, solutions vary vastly from country to country due to different structures, political systems, cultural backgrounds (Cartesian Latin countries, pragmatic Anglo-Saxon minds, etc.). A feature in common in all systems is the dual aspect of education: preparation of specialists on one hand and general
culture and literacy on the other hand. This raises the problem of writing new curricula about the content of subjects to be taught and of preparing teachers to meet both these objectives.

It appears that beyond the diversity of national situations there seems to be mainly two models of teacher education: one, which may be called the sequential model (in which future teachers first get a sound academic knowledge in a specific subject and then get an appropriate pedagogical training) and a second one, generally known as the parallel model (where future teachers receive a very strong pedagogical preparation and study simultaneously one or, most often, two subjects).

Another problem was concerned with technology: it needs to be clearly defined. It is not just applied sciences, nor an extension of physics. It needs to find its proper place in general education, whereas, currently, it seems to be mainly found, until now, in more professional education.

The high rate of evolution of science and technology calls for a permanent updating of knowledge and of teaching methods of teachers.

A need is felt for more active methods of teaching and in this regard the contribution of exchanging teaching experiences among practicing teachers should not be underestimated. Science teacher associations can play an important role in organising such exchange of views and experiences in Europe.

There is no consensus on the criteria of selection and recruitment for it varies very much from country to country.

Another problem discussed was the teachers' motivation with regard to their continued education (time, money, moral rewarding, etc.).

There seems to be a general concern that teachers who most need professional updating are those who are least likely to take part in the actions organised. One of the questions put to the participants in this symposium is thus: how to motivate such teachers and how to motivate bright and active students to become teachers?

---

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FEATURE ARTICLE

TEACHING SCIENCE FOR SOCIAL RESPONSIBILITY

Roger T. Cross
Ronald F. Price

Introduction

Two developments over the recent past have made possible an improvement in science teaching which will both make it more meaningful and useful to the general school student and more genuinely scientific for those students who will go on to study science further. One of these is the examination of science itself, both on the philosophical and sociological levels (Latour & Woolgar, 1986; Rose & Rose, 1969). That science is a productive force in society has long been recognized, and perhaps no more elegantly revealed than in Lewis Mumford’s *Technics and Society* (1934). Mumford concludes with hope for the future that sends a powerful message down the decades to us:

All that has happened up to now has been little more than a rehearsal . . . for however far modern science and technics have fallen short of their inherent possibilities, they have taught mankind(sic) at least one lesson: Nothing is impossible (pp. 434-435).

The other is the widespread movement to introduce environmental issues into science teaching. Some of this is recorded in the writings of the Science, Technology and Society Movement (STS), e.g., the proceedings of the Bangalore Conference, (Lewis, 1987) and more recently by Yager (1992). Now we have the statement of the influential American Association for the Advancement of Science (AAAS) to support this approach. The AAAS project, *Science for all Americans: Project 2061* (1989), sets out the problems and recommends the necessary action:

The most serious problems that humans now face are global: unchecked population growth in many parts of the world . . . the extreme in-qualities in the distribution of the earth’s wealth . . . the list is long, and it is alarming (p. 12).

*Social Responsibility.* Is the proposed content likely to help citizens participate intelligently in making social and political decisions on matters involving science and technology? (p. 21).

It is here that a socially responsible science education has a vital role to play in the development of a more meaningful science education during schooling (Layton et al., 1993).

Many science teachers are worried by these developments, fearing unfamiliar approaches and often lacking help. Some fear the science is being replaced by matter which should be taught by other disciplines. In some cases superficial approaches and ‘preaching’ leads, not to interest, but boredom. Here at La Trobe University we have taken these doubts and problems into account and developed an approach to the social responsibility of science which concentrates on the special skills and responsibilities of the science teacher. It emphasises the principles and methods of science in such a way that they can be better related to the problems facing us in today’s and tomorrow’s world.

It was Joseph Schwab, in the post-Sputnik curriculum development days who complained that ‘the standard rhetoric of textbooks even at the college level’ was one known as a ‘rhetoric of conclusions’ (Schwab, 1963, p. 39). Our aim has been to get away from this and show how scientific theories are produced to describe and explain the observations that we make. We present a process for the preparation of the teaching of controversial scientific topics by teachers, it proceeds teaching and should be viewed as professional development by the teacher, because it involves personal research into the issues surrounding the controversy. We began from a consideration of the skills required which a training in science can provide. These are:

**The Skills Required:**

1. For understanding the arguments involved in the issue;
2. For judging the experts’ opinions;
3. For carrying out independent investigations, in the literature and in the field;

Following that we identified a number of procedures which teachers need to take in preparing to handle a particular social issue in science, whether the greenhouse effect, nuclear energy, or the use of CFCs.

In the course of working through these procedures
teachers will be able to decide on a unit and individual lesson plans. Many of the procedures will be repeated by the students in the course of the unit.

Professional Development Procedure:

1. **Defining the Projects:** the kind of social issues which are likely topics are usually too broad to be successfully handled as a single project and it is therefore desirable to begin by considering how they might be broken up into separate projects. Then you must decide whether to select only one of these for detailed examination or whether to allot different projects to different groups of students within the class.

2. **Sorting the Questions:** this step involves brainstorming the questions involved in the selected project (ionising radiation; water pollution; genetic diversity) and then grouping and sorting them. They need to be sorted in various ways: according to discipline type: ethical, political, economic, scientific, etc., and according to whether the answers are known or disputed. Decisions must be made as to which questions are too difficult, for whatever reason, to handle, and which will be of the most educational benefit to pursue.

3. **Handling the Arguments:** this is a particularly crucial step, involving setting out and analysing the steps of arguments to answer the questions selected in Step (2). What kind of evidence is involved (e.g., chemical, statistical)? Are there problems of terminology, conceptualisation or logic? What prior knowledge or skills are required of the students? This last leads to a choice of teaching methods but we see Handling the Arguments as a prior step. When handling the sociopolitical and economic aspects of a question an important consideration will be the identification of the various interest groups ("stakeholders") involved. As well as interests there are questions of values. Of course, during teaching students may bring up other arguments which you may not have anticipated. They should then be encouraged to follow a similar process of setting it out and analysing the steps.

4. **Considering the Concepts:** students appear to find this a very difficult task, often failing to understand that a concept is simply *meaning* of a term, something which may or may not require an unfamiliar word (table does not, metabolism probably does), but certainly requires definition. In handling an issue it is necessary to consider what is the minimum list of essential concepts, which, if any, are likely to give difficulty, and how to handle that difficulty. Drawing concept maps can help develop understanding of the ways in which concepts are linked together.

5. **Particular Teaching Methods:** consideration of stages (3) and (4) will reveal whether there are particular problems which require particular methods. Brainstorming and cooperative learning strategies (Hassard, 1990) are we believe the most appropriate. Empowerment of the students in terms of the acquisition of the desired skills comes from their own activities—rather than didactic teaching methods. One strategy that has been used is the debate. We have not found these at all satisfactory—they often degenerate into a simplistic two sides affair—a much more useful strategy is to be found in Value Tree Analysis—where various groups are stakeholders in an issue and cases for particular solutions to an issue are put with the view of finding a just solution (von Winterfeldt, 1986).

6. **Resources:** these will probably always be a difficulty, this is in part because a good issue is controversial and many of the resources will be partisan and in part because we will want to use up-to-date and therefore scattered materials. The materials often pose difficulties of language and style and too often lack details of the evidence required for successful learning of the skills of evaluation.

Having completed these steps teachers will be in a position to quickly develop the topic suited to the particular class. Many of the activities which the teacher will have carried out as part of the professional development of the resources and understanding of the controversial issue will be repeated by students in the course of the unit. They benefit from the teachers own experience and increased confidence in acting as a resource.

The Social Responsibility of Science in Science Education Research Group at the Graduate School of Education, La Trobe University, Melbourne, Vic. 3083, Australia would be delighted to hear from
any persons of similar interest in promoting science education.

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Cross, R. T., & Price, R. F. (in press). Scientific Issues and Social Awareness: The responsibilities of science teachers; A case study approach, the example of biological diversity. School Science Review.


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Science Education International, Vol. 5, No. 2 June 1994
Science Education Around the World

Member associations and individuals are invited to contribute to this section. Suitable items include brief accounts of specific projects of international significance, science education in a particular country, or international and regional seminars and conferences.

BOLIVIAN REFORM EFFORTS:
A STATUS REPORT

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All across the world, educational systems are under a push for reform. In Bolivia, a country located in the central part of South America, the current battle cry is no different. Like many countries, the current educational system has dominated the horizon for many decades unyielding to the challenges of concerned patrons, teachers, and government officials.

The current system of education in Bolivia provides for four levels of instruction: preschool (two years, pre-kindergarten to kindergarten), elementary school (five years, first grade through fifth grade), intermediate school (three years, sixth grade through eighth grade) and secondary school (four years, ninth grade through twelfth grade). Most schools in Bolivia are state supported (88% of the enrolled student population) with far fewer attending private schools (12% of the enrolled student population) of which most are supported by the Catholic Church. It is also worth noting that the majority of the schools are found in the urban areas of Bolivia with few located in the rural areas.

The Issues

Even though schooling is obligatory by law, the Bolivian population has a large percentage of illiteracy. This is largely due to the fact that many individuals in Bolivia are segregated in rural areas and small towns and still maintain ancient cultural values which do not place an emphasis on “modern education.”

In regard to science education, it is fair to say that in general terms the quality of instruction offered to Bolivian students is low. Only the 12% or so that attend private schools have access to “modern” equipment, textbooks, technology, adequate physical plants, and other curricular resources. Unfortunately, private schools are very expensive and only the elite social classes of the Bolivian population can afford to send their children to these schools.

In addition to the aforementioned obstacles, there are other numerous factors which contribute to the poor quality found in many Bolivian schools. First, as previously mentioned, the educational system is elitist based and does not take into consideration the Bolivian social, cultural, ethnic and linguistic diversity of its population. This becomes even more critical in light of the fact that many individuals still hold to mystic or ritualistic beliefs about the nature of science. This is not a little disturbing since UNESCO’s declaration for Project 2000+ (1993) indicates that “[s]ound education is fundamental to the strengthening of higher levels of education and of scientific and technological literacy . . . that scientific literacy and technological literacy . . . that scientific literacy and technological literacy are essential for acting responsible and sustainable development” (p.6). Without the development of programs that take into consideration the diversity of the population, Bolivia meeting the goals of Project 2000+’s will be difficult at best.

Secondly, and closely related to the first concern, is the issue of language. The Bolivian educational system has ignored the fact that many individuals, especially in the rural and low socio-economic areas, do not speak Spanish as their first language or at all. Yet, few teachers prepared to teach in the Bolivian system are bilingual. Disconcerting as this is, it is even more so when one considers that scientific language or the style of language used in science can cause difficulties for students as they attempt to learn science concepts (O’Toole, 1993).

Finally, the teachers who are prepared to teach in the Bolivian school systems are, for the most part, trained...
in a perfunctory manner. Teachers are educated in a Normal School with an emphasis on science content and laconic methods for the transfer of this content to their students. Little time is spent on the methods of teaching science. Little time is spent on the methods of teaching science. Learning theory, or curricular theory. Most of these schools are poorly funded and lack the material resources (i.e., technology, curriculum, laboratory equipment, etc.) to provide the teachers with appropriate experiences in preparation for teaching science. The emphasis is placed on the coverage of content through repetition and rote memorization. In addition, many teachers in Bolivia who teach science have no formal training at all. These teachers called "interim teachers" are hired because of teacher shortages due to low pay. The teaching of science and math by teachers who are not qualified and educated to do so many times leads to rigid teaching styles. In addition, teachers tend to stick closely to notes that they have prepared and avoid dealing with student questing which could unveil the teachers true understanding of science (Stoll, 1994).

The Current Reform

Although the odds seem insurmountable, Bolivia is making headway regarding reform for science education and education in general. As a basis for the reform efforts in science, Bolivian educators agree that reform (or change) is never easy and the first steps to implementing change is recognizing that problems exist (Cushman, 1993). In addition, it is understood that the actual situation of the Bolivian educational system can not be improved by isolated and simple proposals and strategies, but by a deep transformation that will give solutions to the causes of the poor quality of education and provide for systemic change throughout the whole educational system. It is also apparent that in order for systemic change to occur, the school systems and teachers will need assistance. More specifically, Bolivian science educators will need an "[e]nvironment that is both enabling and motivational—providing sanction, protection, capacity, knowledge, resources, and the opportunity to change—combined with a set of expectations and the sensitivity to know when, where, in what direction, and how hard push" (Donahoe, 1994; p. 302).

In light of the aforementioned needs as it pertains to systemic reform, there are some basic designs for educational reform in Bolivia. A first step in the reform effort is to address the education of all students in Bolivia, both rural and urban. This follows the goals of Project 2000+ as Holbrook (1993) stated, "Project 2000+...[is] a scientific and technological dimension of basic education in the context of education for all" (p. 4).

This, however, will not be at a small cost. Consideration will need to be made for the diversity of students within the country itself. Curricula will need to be developed keeping in mind the cultural beliefs and practices of the students. As Stoll (1992) so aptly explained, many of the textbooks and curricula in developing countries are western in nature and do not into consideration the cultural, ethnic and linguistic diversity of a country such as Bolivia. The reform effort will focus on the development of new curricula which will utilize traditional technologies and crafts as part of the focus. In addition, an emphasis is being placed on the development and implementation of technology that will assist in the instruction process.

In addition to changes in the curricula, teacher education itself is being radically changed throughout the country. Science teacher preparation programs will no longer exist solely in the normal schools. Universities are implementing programs that focus on contemporary, quality pre-service education programs that have as their focus not only the learning of content, but also, learning about learning. More specifically, the education of teachers will focus on the cognitive, affective and physical development of students. Contemporary methods of teaching will also be taught to the pre-service teachers such as the whole language approach, constructivist method of teaching, and cooperative learning, etc. Emphasis will be placed on teaching children critical thinking and problem solving skills rather than the rote memorization of facts related to science.

The overarching goal of the program is to prepare teachers who can teach students to be scientific and technologically literate life long learners. In addition, substantive changes are being made to educate teachers who are bilingual and can address the needs of the students who are non Spanish speakers or at best, have Spanish as a second language.

In addition to the above, plans are being made to implement the following:

- Develop ongoing in-depth staff development programs for existing teachers.
- Create summer and winter institutes for continued development of teachers knowledge base.
• Institute advanced degrees in the area of teacher education.
• Develop research programs which examine critical issues in education pertaining to Bolivia.

Implement assessment strategies which are more closely tied to the current changes in instruction and curricula.

Conclusion

Overall, this is a big step for the entire educational system in an underdeveloped country that is moving towards systemic reform. Overhauling the science teacher education process; the development of new curricula which is sensitive to the nature and needs of the students; scientific literacy, the development of problem solving and decisionmaking skills as a critical component of students education, as well as empowering students to be life long learners are all worthy goals that will take time and substantial effort to implement. However, taken together these changes could have an immense impact on the future of Bolivia.

Although there may be many reasons to doubt the changes will occur, the vision has been established. Without a vision of what can be, we will never start our journey. And, it is through this journey that we encounter difficulties that provide us with experiences, and experiences in turn bring us wisdom to understand change.

References


Science Education International, Vol. 5, No. 2 June 1994
The Present Education System

There are three clear sectors—the primary sector, the post-primary/secondary sector and the post-secondary sector.

Qualifying examinations mark the transition from one sector to another and also several within-sector transitions. These examinations act as hurdles in some cases. The first hurdle is the Common Entrance Examination taken at age 11. The level of success in this examination determines the type of secondary school to which the student goes. The older established traditional schools are generally favored over the new sector schools with the result that places in the traditional schools are in great demand. Consequently, only those students who have scored very high marks on the Common Entrance Examination gain entry to these schools. This represents only a small percentage of the secondary school intake. The remaining students attend the new sector schools.

The goal of free secondary education for all has not yet been achieved. The present provision is for about 75% of the eligible students. The remaining 25% either repeat the Common Entrance Examination if they are young enough, or else they may proceed to the post-primary sector. There they take the School Leaving Examination after a further two years, success in which may help them gain entry to the Youth Camps or Trade Centers for vocational training.

A qualifying examination (the 14+ examination) marks the transition from the Junior Secondary school to the Senior Comprehensive school. This examination does not really serve as a hurdle because the transfer from one level to the next is automatic. The 14+ examination is supposed to serve as a diagnostic examination to assist with the placement of students in appropriate tracks at the Senior Comprehensive level, but it is doubtful that it really serves this purpose. Students who are admitted to traditional schools or Composite schools do not write the 14+ examination.

Students from both new sector and traditional sector secondary schools write the regional Caribbean Examinations Council (CXC) examinations after five years of secondary schooling. For many students, this represents the end of their secondary schooling. Some of them seek employment at this stage. Moderate success in the CXC examination enables students to move on to tertiary institutions such as the technical institutes and the teachers’ college for primary teachers. Less successful students may enter the Youth Camps or Trade Centers. Students who excel at the CXC examinations usually continue in secondary school for a further two years and take the Cambridge CGE “A” Level examinations at the end of this period. Successful “A” Level candidates can enter university (local or foreign) or some other tertiary institution, or else join the work force.

Emphasis of Science in the Basic Education Cycle

In Trinidad and Tobago, the basic education cycle as defined by the Commonwealth Secretariat covers the primary school and the first two years of the secondary school, the first nine years after the start of compulsory schooling. A more natural segment of the system is the first ten-year period, that is, the period from the start of the primary school to the end of the third year of the secondary school when students in the Junior Secondary schools transfer to the Senior Comprehensive schools. This is the segment that will be referred to in this discussion.

Science is compulsory for all students for the first ten years of schooling. It is offered as “science” at the primary level and variously as “general science,” “integrated science,” and the separate subjects of chemistry, physics and biology in the first three years of secondary school. Individual secondary schools have some measure of freedom in deciding how science is to be taught in the first three years.

Science A Process Approach for Trinidad and Tobago (SAPATT), the official science curriculum for primary schools in Trinidad and Tobago, was derived from the American SAPA—Science A Process Approach. This curriculum is tested in the science component of the Common Entrance examination. Teachers’ Guides giving detailed suggestions for lessons are available. Student workbooks which match the outlines in the Teachers’ Guides are also available. This curriculum is very heavily biased towards the science processes; the science content/concepts in each lesson serve only as the vehicle for teaching/learning the designated science processes.

At the lower secondary level, the situation is not as clear-cut. In the new sector schools, there is an official government syllabus which stresses both content and process. The schools in the traditional sector, however, all tend to construct their own syllabus which is in many instances patterned after
one of the popular science texts for that level. In such cases, the emphasis is usually very much on content.

**Strategies for Teacher Training**

Within the recent past, a short induction course has been organized by the Ministry of Education for persons about to begin teaching at the primary and secondary levels. However, there are no full pre-service teacher training programs in Trinidad and Tobago today, though this system has operated at the primary level in the past. Both primary and secondary school teachers are now trained in inservice programs, the former group at the government-run Valsayn Teachers' Training College and the latter at the Faculty of Education at the local campus of the University of the West Indies.

The course at the Teachers' Training College lasts for two years and requires full-time attendance. Teachers typically teach for 23 years before they gain acceptance into the college. To gain entry to the college, teachers must possess passes in 5 CXC (or GCE "O" Level) subjects, including a science subject. The core curriculum covers the general education foundation areas, methods courses and content courses in the various subjects taught at primary school. Students must also choose one subject (called an elective) in which to specialize at a more advanced level. Typically, the advanced science group consists of no more than 15 students in any one year. This is but a small percentage of the total college population (See Table 1). The core science curriculum at the college has been designed to mirror the process-based curriculum in use in the primary schools.

Secondary school teachers are trained at the University of the West Indies on the Diploma in Education (Dip. Ed.) program. This is a post-degree, one-year, inservice program. Teachers attend lectures during the school vacations, beginning with an intensive session in the summer of each year. They also attend lectures for one day during the week during term time. University tutors visit teachers in their home schools at intervals to monitor and tutor them in their classroom practice.

In addition to a core curriculum consisting of the normal foundations of education courses, there are specialist curriculum courses. Each student must register in one curriculum area. Roughly 20 students register in the science curriculum area each year. The general aims of the science curriculum component of the Dip. Ed. program are that teachers will (i) apply understandings about science as a discipline, (ii) apply general education principles through the teaching of science and (iii) develop and manifest favorable attitudes to the learners, science, technology, their teaching and their self-development.

There is a large backlog of untrained secondary school teachers since only about 100 students can be trained in the Dip. Ed. program each year (Table 1).

Workshops are also mounted periodically for both primary and secondary school science teachers by the Ministry of Education. Sometimes, these workshops are a joint effort of the Ministry of Education, the Association for Science Education of Trinidad and Tobago (the local science teachers' association) and the Faculty of Education of the University of the West Indies. Issues that are of specific concern to teachers (for example, school based assessment) are addressed at these meetings.

**Commentary**

Science as a school subject is held in high esteem in the society at large. This does not mean that the teaching of science in the schools is non-problematic. Problems exist particularly at the primary level and two main reasons can be advanced. First, many of the primary school teachers (who must all teach science) have a very weak background in science. Some of the older teachers did no science at all after their third year of high school. These teachers are forced to teach science because it is examined at the Common Entrance examination, but many feel very insecure doing so. The second reason is intricately linked with the first. The process-based approach is radically different from the traditional way of teaching science. Primary school teachers are therefore not only faced with teaching a subject in which they do not feel they are competent, but they are also faced with the problem of teaching it in a new and strange way. Many of them adopt the coping strategy of sifting out what little science content there is in the lessons to be taught (and the topics are usually not logically connected) and giving the students copious notes on these topics. The net result is that many students leave primary school not liking science.

The problem is less acute in the secondary schools because here teachers are likely to be university graduates in science or at the very least, hold GCE "A" level passes in one or more science subjects. There is however the continuing problem of science being taught as a body of facts only. Teachers in the Junior Secondary schools continue to complain that
the official syllabus is too demanding for students. Some of them have done their own modifications to this syllabus.

It is not likely that there are any easy solutions to these problems. At the Junior Secondary level, the solution would seem to lie in training teachers to understand their students and the contexts in which they work and to develop skills in adapting official syllabuses and guidelines to meet their own situation, pulling on the resources of their particular environment.

At the primary level perhaps a whole new administrative approach to the teaching of science is needed. Some schools have already begun to experiment with re-organizing their staff so that the teacher with the best science qualifications (perhaps science at the elective level at the teachers' college) can function as a specialist science teacher in the school. This emerging model holds some promise and needs to be researched and tested in a serious manner.

Both at the primary level and at the lower secondary level there is the perennial problem of lack of equipment for practical activities. Process science cannot be taught without equipment, though such equipment need not be costly or elaborate. Low-cost equipment initiatives have not featured very much in Trinidad and Tobago and may well be pursued. Even with such a strategy, one needs to be mindful of the amount of time that a teacher can reasonably be expected to spend making equipment, given other pressing duties. Perhaps woodwork and machine shops in schools as well as Youth Camps and Trade Centers can be organized to help in this area. There has been a suggestion here in Trinidad and Tobago that a mobile laboratory be developed to service primary schools. This is a worthwhile idea, though there are serious cost implications here.

Despite the problems outlined above, students have passed through the system and done well in science. However, this is but a small percentage of the student population and there is thus the need for systematic research and development activity that is aimed at the wider school population. If science is to play its role effectively at the basic education level in Trinidad and Tobago, much time, money and effort must be put into working with science teachers and setting up appropriate support systems.

Table 1. Statistics on Education System of Trinidad and Tobago 1986-1991

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Sources: Ministry of Education, Trinidad and Tobago; Faculty of Education, U.W.I., St. Augustine, Trinidad.
Research on Curriculum, Teaching, and Learning

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USING MINDS-ON SCIENTIFIC DISCREPANT EVENTS TO MOTIVATE DISINTERESTED SCIENCE STUDENTS WORLDWIDE

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Introduction

Science teachers worldwide would mutually agree that when children are confronted with a science problem-solving task, they construct characteristically individual representations of the given task; and, they will base their orientation of approach, whenever appropriate, from prior experiences in similar settings. Thus, children’s viewpoints are a combination of cognition, personal interpretations, and psychomotor skills. In general, then, “A learning experience commences with some new encounter which the learner interprets and makes sense of in terms of his or her existing cognitive structure” (Appleton, 1993, p. 269).

Providing all learners with motivating experiential activities is an important didactic strategy, especially when teaching abstract science concepts and principles. Each learner is unique in terms of their receptivity toward learning science. Thus, worldwide, teachers always come across some disinterested students who are reluctant to participate in the learning process. However, disinterested students are eager to learn when their curiosity is triggered, or when a novel idea is presented which poses a conceptual conflict in their understanding.

Experiential activities, which may be thought-provoking (minds-on) or hands-on activities, must stimulate curiosity and motivation to comprehend a phenomenon. The more contradictory the phenomenon appears to their strongly-held notions of the event, the better is their approach to overcome the contradictions.

Piaget’s cognitive position on the subject of curiosity has been aptly summarized by Charlesworth (1969) thus:

Intellectual change or growth is the end result of a chain of events beginning with the disruption of cognitive equilibrium by a conflict between incoming information already stored in the central nervous system. The conflict produced by the discrepancy between these two sources of information has the capacity of motivating curiosity (exploratory) behavior, and the latter has a high probability of leading to information that can be used by the organism to reduce conflict. Conflict reduction consequently reinforces the curiosity behavior, thereby insuring continued contact with novel features of the environment (p. 273).

Discrepant Events

Motivating disinterested science students to successfully learn and apply concepts and principles is not particularly difficult when an inquiry approach to teaching science is used by the teacher. To initiate and sustain motivation, discrepant events serve as excellent sources of pragmatic learning. In fact, “Discrepant events provide teachers with many simple, concrete and easy-to-use examples of events or situations that encourage good teaching practices” (Kavogli, 1992, p. 10).

According to Wright (1981) and Wright and Govindarajan (1992), a discrepant event is a phenomenon which occurs such that it seems to run contrary to our first line of reasoning; and, it is a good device to use in stimulating student interest in learning science concepts and principles. Kavogli (1992) points out the merits of using discrepant events, thus:

It is obvious that when students are strongly motivated conditions are favourable for learning. Therefore, any method that helps generate this motivation is worthy of investigation. Thus, discrepant events capitalize on the students’ curiosity, helping him/her gain a better understanding of science (p. 10).

A related viewpoint arrives from the conceptions of learning and approaches to learning; this viewpoint attempts to clarify on how students go about the business of learning. Iran-Nejad (1990), citing interesting research reports, highlights the findings of several researchers [see Iran-Nejad, 1990], by dentifying the types of learners:
The majority—more than two-thirds—view learning as knowing more, memorizing for later reproduction, or acquiring and using facts. These students tend to take a surface approach to go about the business of learning. In sharp contrast are those—less than one-third—who believe that learning involves insights into the subject matter, new ways of thinking about reality, and personal growth. These students take a deep approach to learning (p. 577).

We believe that most disinterested science students are in the former—more than two-thirds—group of students (surface learners). And, as discerning and conscientious teachers, it is to this group that we must provide them with appropriate experiential and motivating activities so that they may enjoy the benefits of taking a “deep approach” to learning, just as their counterparts (the deep learners) do.

Minds-on Examples

Our intention in this article is to go beyond providing solely theoretical constructs and implications for the use of scientific discrepant events. The reader may find it interesting to peruse the informative resources authored by Kavogli (1992); Wright (1981); Thompson (1989); Wright and Govindarajan (1992), (1993); and, Cobb and Darling (1990). We have provided here a list of minds-on examples [see Figure 1] which the science teacher may use to dramatically introduce concepts and principles to students. We would like to emphasize, however, that the examples should be used to provide a medium to enhance students’ inquiry skills—an essential learning aspect fundamental to the development of problem-solving skills. We emphasize this because “Unfortunately discrepant events are often misused in classrooms. Teachers use them as shows of magic rather than for the science principles they demonstrate” (Thompson, 1989, p. 28).

Considering the utility value of using scientific discrepant events in the science classroom, we agree with Kavogli’s (1992) observation that,

Although there is considerable value in the use of discrepant events, it is obvious that these cannot be developed for every topic or scientific principle. In the absence of an appropriate discrepant event, it is entirely acceptable to present non-discrepant events in which the students have a chance to observe or perform some kind of investigation. The main point to remember is that the event is used as an incentive to student involvement. Discrepant events are [to be]

presented whenever possible, supplemented with non-discrepant events whenever needed (p. 10).

We hope science teachers all over the world will enjoy using the examples provided here; and, motivate students to work with their peers to research further and develop practical skills of report writing and presenting to the public. We also encourage teachers to add more such discrepant events to their library of knowledge. In closing, we would particularly welcome you to share your examples with us. Please write to:

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References


<table>
<thead>
<tr>
<th>Phenomenon, Question, Event, or Statement</th>
<th>Student's Response</th>
<th>Conceptual Discrepancy</th>
<th>Scientific Concept/Principle Illustrated by Conceptual Discrepancy</th>
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<td>Physics</td>
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<td>When a teaspoon is placed in a glass cup, it may help prevent the glass from cracking when hot water is poured into the cup. True or false?</td>
<td>False. The glass cup cracks anyway because the outer layer of the glass will experience a strong pressure from the expanding inner layer which is in contact with the hot water.</td>
<td>True. To begin with, the thermal conductivity of glass is the same at every point in the glass. Also, glass <strong>does not</strong> consist of layers—it is an amorphous solid.</td>
<td>Now, when a metal spoon is placed in the glass cup and the hot water is poured onto it, the hot water will rapidly lose heat to the spoon. The water temperature will drop low enough so that the coefficient of thermal expansion of the glass can accommodate the thermal stresses generated by the hot water.</td>
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<td>Chemistry</td>
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<td>Place a sugar cube on a porcelain dish, and unknown to students sprinkle some cigarette ash on the cube. After this preparation, ask students: Is it possible to light sugar cubes with a match?</td>
<td>Impossible. However, we do know that sugar chars when in contact with fire; but, it will not catch fire.</td>
<td>Possible. If the sugar cube has a catalyst that supports combustion, it will catch fire. [Have a volunteer step forward and light the sugar cube with a match; the sugar cube will catch fire.]</td>
<td>Cigarette ash functions as a catalyst and promotes the burning of the sugar cube at a lower kindling temperature. Thus, cigarette ash could be shown as a promoter of combustion. Ask students to identify similar catalysts in chemical reactions, as well as in the environment.</td>
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<tr>
<td>Phenomenon, Question, Event, or Statement</td>
<td>Student's Response</td>
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<td><strong>Earth Science</strong></td>
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<td>All rocks will sink in water. True or false? Show students a piece of pumice (a type of rock; available in any general store), and ask them again: Will this rock float? Students' observations of the specimen show (which resembles a granite) will cause them to spontaneously respond.</td>
<td>True. No, it will not float; it is a rock! [Invite a volunteer to float the specimen in a 500 ml beaker of water. To the amazement of the audience, the specimen will float.]</td>
<td>False. Like in any area of knowledge, scientific phenomena also have their exceptions. Pumice, even though a rock in its characteristics, is an exception to the rule that all rocks will sink in water.</td>
<td>Pumice has a density (which varies by the number of pores in it) that is less than that of water (1g/cm³). The rock is an extremely vesicular (porous), frothy, natural glass. Due to its low density, it floats on water. Have students conduct a library research to document the properties of pumice, and how it is used in our daily environment. [Pumice is used, for instance, as a household scrubbing material for scrubbing sinks; the rock is capable of removing stains.]</td>
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<td><strong>Biology</strong></td>
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<td>If you carve your name on the trunk of a tree at five feet above the ground in 1994, after 50 years the name will be several feet higher (assuming that the tree has not been cut down). True or false?</td>
<td>True.</td>
<td>False. The name will remain at the same height. The growth region is in the tips of the plant and in the cambium. Therefore, the region where the name has been etched remains unaffected in terms of vertical growth.</td>
<td>In plants growth is largely at the terminal ends. The greatest amount of cell activity takes place at the apical regions of roots and stems and the branches. Of course, plant growth also occurs on the lateral surfaces of the stem and roots; however, this growth is a result of a single tissue, cambium, which gives rise to tissues forming the bulk of cells in the plant body. In leaves, however, there is an exception to this principle. Growth and enlargement is fairly uniform throughout the laminar surfaces. Ask students to work in groups on library research work to determine the factors and conditions under which leaf growth takes place in plants, and also why leaves of different plants differ in size.</td>
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Teaching Materials and Strategies

IN-SERVICE AND INITIAL TRAINING OF PRIMARY TEACHERS:
A FLEXIBLE RESPONSE

Eric Parkinson and Don Plimmer
Canterbury Christ Church College

This article describes an innovative initiative between Canterbury Christ Church College, UK and the Commonwealth of Learning, Canada. It describes the use of flexible learning materials to support initial and in-service training, and curriculum development, in primary schools. This collaborative operation has implications for potential users world-wide, with special reference to those in developing countries.

These days, it seems the only consistent feature in INSET and initial training is Change. This is a somewhat daunting prospect for all concerned.

Changes in patterns of delivery, changes in content, in professional emphasis and indeed, in recruitment patterns have required constant adjustments to courses. In response, staff have had to consider new and imaginative modes of course design and delivery.

At Christ Church College, over seven years ago, a piece of inspired thinking produced the basis for a new generation of course materials which might, it was thought, have the capacity to weather the changing vistas on the horizons of science education. The outcome, “Success with Primary Science” was a flexible learning package which could be used in both in-service and initial teacher training programmes and in a wide variety of different conditions and delivery modes.

The resulting product offers support to teachers in their classroom practice and at the same time develops their understanding of science. Also, through the medium of the classroom, professional issues are tackled and considerable emphasis is given to the issue of reflecting upon and analysing the classroom performance of the course participants themselves.

Initially the materials were used to support local in-service courses, but soon the word spread and so did the materials, as partnerships developed with Local Education Authorities in the UK. A copy of the materials found its way as a gift to a pioneering multiracial teacher training college in the period before the dawning of the “New” South Africa and so it was that the internationalisation of the materials began.

Originally, Success with Primary Science had been devised in a somewhat random fashion so that teachers would be attracted to “do some science” with their classes by virtue of working through the materials themselves, in pursuit of an in-service course. This reflected the pre-UK national curriculum atmosphere of 1987 in which science was a “do some if you can—but not to worry if you can’t” Cinderella subject in primary schools.

A re-write was undertaken in 1991 to accommodate the UK National Curriculum, with its new, dedicated language embracing terms like “attainment targets” and “statements of attainment”. Soon however, reflecting this theme of change, the national curriculum itself underwent a revision and the materials were once more out-of-step.

By 1993, it was becoming clear that the materials needed yet another substantial re-write. This time the bold decision was taken to write out references to the UK national curriculum. Chasing what seemed to be a biannual revision of the curriculum was a game that could be ill-afforded so the editors stopped playing “chase the attainment target”!

The third edition of Success with Primary Science is now arranged in small units which address key issues of professional concern as well as core conceptual areas. Teachers have found that they can use these, both as part of their teaching programme, and alongside it as essential background reading.

The materials have thus become even more flexible, since they can be used directly in schools to support the teaching and learning of the children and teacher alike!

Naturally that does not mean that the whole course revolves around flexible learning materials. Canterbury Christ Church has developed a number of support systems to accommodate and manage a range of course types. It is recognised that local meetings of participants, with, and sometimes without a tutor, are valuable. So too can be a network of telephone numbers for contact between participants and the tutor.
Arising from the rapid spread of Success With Primary Science, a flexible follow-on course was devised. This course, “Managing Primary Science”, focuses on the challenge of professional and curriculum development, not at the individual teacher their classroom level, but on the whole school. As such it reflects a natural progression in In-service development.

The application of flexible learning materials to INSET is one field, but increasingly they are being used for the initial training of teachers as well. They are an ideal way of assisting in the provision of differentiated learning opportunities, especially in environments in which increasing student numbers may put a strain on traditional means of course delivery.

The materials for Success with Primary Science, and its follow-on cousin Managing Primary Science can be shared on a world-wide basis. The Commonwealth of Learning (COL) based in Vancouver and Canterbury Christ Church College hold the publishing rights to these materials. COL is dedicated to the dissemination of flexible learning materials with particular reference, as their name suggests, to the Commonwealth.

Fax COL on int. + 604 660 7472 for further details.

Canterbury Christ Church College can be contacted on Fax int. + 227 470442

There is a final added bonus to be gained from the use of these flexible learning materials which is as follows. Many developing countries may look towards flexible learning materials in order to optimise limited resources. However, evidence suggests that there is massive potential for professional and curriculum development to be gained by re-writing and restructuring the materials to fit local needs and conditions.

The flexible learning materials offer a central spine of ideas. Teachers can take these ideas and adjust them to fit in with local circumstances. They can, for example, develop a whole new generation of workshop materials for colleagues to deliver.

And of course, both the products and the processes of curriculum development are of significant benefit.

The Commonwealth of Learning and Canterbury Christ Church College, both with a great fund of international consultancy experience, are keen to develop world-wide links with all who seek further information.

Eric Parkinson and Don Plimmer are both Senior Lecturers at Canterbury Christ Church College. Between them they have wide experience of education not only in the UK, but also in the Caribbean, Far East, North America and most recently, South Africa. Both are currently involved in a project which seeks to upgrade teacher confidence and understanding of basic concepts in science, with course participants drawn from South Africa.

Three Primary Science teachers are hard at work on an electricity and magnetism unit during a tutorial meeting.
Science Teacher Education and Leadership

THE LESOTHO INDUCTION PROGRAMME

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The section editor would like to thank Leo de Feiter of DCDS, Free University Amsterdam for assistance in editing and background information on the induction program.

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Introduction

Lesotho is a small, mountainous country surrounded by South Africa. It has been an independent country since 1966. Prior to that it had been a British Protectorate. Its educational system is still largely modeled after the British system. One of main problems in education is the retention of newly trained teachers. Many leave the profession within a few years to work in South Africa. Especially in science and mathematics there is shortage of qualified teachers.

The Problem of First Year Teaching

The first year is probably the most eventful and by far the most difficult in most teaching careers. The beginning teacher, just out of university or college, and most likely with little or no previous teaching experience, faces a host of tasks, all unfamiliar and difficult to handle, and more often than not with precious little support during these first crucial months. Vonk (1984) has researched extensively in this area, and much of the material described in the following is based on his work and ideas.

It is during the first year that the teacher forms her attitudes towards the teaching profession in general. Ways of handling problems relating to classroom management, choice and administering of teaching methods and teaching aids, administration of the curriculum and staff room procedures have to be developed. One has to find ways of fitting in with the administration and management of the school and the whole educational system. Not to speak of dealing with parents and extra-curricular activities. The list is endless.

This section focuses on the education of science teachers, and aims to communicate ideas and strategies which will assist science teacher educators to enhance and enrich their programs.

In Lesotho, like in many other third world countries, the problems of beginning teachers are magnified by factors like the high student-teacher ratio, often exceeding 50, poorly equipped schools, in particular in the sciences, little cooperation between colleagues in the school due to high staff turn-over, the recruitment of unsuitably qualified teachers and expatriate teachers, and the tendency in many schools to hold on to educational habits introduced in the colonial era.

The gap between theory and practice is real and the teacher training institutions attempt to prepare their students for the new situation they are to face. Some are more successful in their endeavors than others, but no matter how well the pre-service instruction is geared towards helping the novice teachers getting started, there will always be that reality shock when the new teacher faces the classroom situation for the first time.

It is exactly to try to help the beginning science teacher to deal with this situation that the Induction Programme of the Science Education Department of the National University of Lesotho came into existence in 1988.

The Start of the Induction Programme

The idea of starting an Induction Programme to help the new Science and Mathematics teachers get a better start in their profession was developed at the Centre for In-Service Education of Mathematics and Science Teachers (CIEMST), which forms part of the Science Education Department of the National University of Lesotho. Approval was obtained from the Ministry of Education, and the programme started with a Pilot Year during the academic year 1988-89. Funding was granted from the European Community (EC) and the Netherlands Government for the running of the Induction Programme for a period of 4 years from 1989 till 1993. The programme constitutes a
cooperation project of the National University of Lesotho with the Vrije Universiteit Amsterdam.

**Development of the Induction Programme**

In the Pilot Year (1988-89), 7 Beginning Teachers, all graduating in Science (including Agricultural Science) and Mathematics in the secondary sector, participated in the programme. The following year (1989-90), 19 completed the programme. A rapid growth was experienced in the following two years, and the Programme has now stabilized with a participation of between 70 and 80 beginning teachers every year. The target group of Science and Mathematics teachers was expanded with a smaller group of Home Economics teachers from 1990-91, and most recently 10 teachers of Business Studies graduating from the National University have been invited to participate as well. In the last couple of years, after the programme has become known and accepted, the enrollment percentage stands at between 85 and 90 out of those who are given the option to join the programme.

As from July 1993, the Induction Programme has been requested to extend its offer of support to teachers of the humanities as well. This is now happening with the result that the programme will grow to about twice its former size.

**Approach of the Induction Programme**

One important principle in the programme is that participation is voluntary. However, an agreement is entered into with the beginning teacher, committing her to participate in all the activities of the Induction Programme once she has joined it. No credits are awarded for participation. On the other hand, no cost for the participants is involved, all expenses being covered from project funds.

Furthermore, it is important that the head of the school, where the new teacher has been employed, agrees to her participation in the Induction Programme. The activities of the programme are partly school based and partly centered around workshops and seminars, for which the teacher has to travel. However, these mostly take place during holidays and weekends. That way the Induction Programme does not impose on the daily routines of the teacher.

**The Programme**

The Induction Programme, in its present form, operates with the following aims and objectives.

The **Aims** are to help the Beginning Teachers taking part in the Programme to:

1. develop confidence in themselves as teachers and to acquire a positive attitude towards the teaching profession;
2. learn to care for their pupils and to appreciate their individual strengths and weaknesses;
3. become able to realize their own potential as teachers and to improve their teaching;
4. fit into the school environment as members of staff and departments; and
5. as a result of the above to gain job satisfaction, expressed as a wish to remain in the teaching profession (teacher retention is a major problem in Lesotho schools).

Thus the **tasks** of the Induction Programme staff are:

1. to devise and administer a package of in-school support to be used by the beginning teachers during their first teaching year;
2. to identify and appoint suitable mentors in the schools and to provide the necessary training for them;
3. to regularly arrange seminars and workshops, linking up with the school based activities and providing necessary and useful input for the participants;
4. to facilitate visits to the schools in order to introduce and set up programme activities and later to monitor the progress of the individual participants as well as to offer any assistance needed; and
5. to provide a natural link between the learning institution and the schools receiving the Beginning Teachers.

The **activities** of the Induction Programme as seen by the participants presently are:

a. Participation in the programme is offered to all graduating Secondary and High School teachers within the science subjects.

b. Participation is voluntary.

c. Participation is subject to the approval of the Principal of the school where the beginning teacher is employed.

d. A mentor is found at the school to assist the beginning teacher. Training is offered to this mentor.

e. An Agreement, specifying the roles of the beginning teacher, mentor, school and the Induction Programme, is drawn up and signed by the four parties.

f. During the induction year, seminars and workshops are held to keep mentors and beginning teachers informed about the
programme activities, school principals are welcome to participate in these activities.

g. In the school the beginning teacher is anticipated to enjoy continual and sympathetic support from the mentor who is specifically trained to perform her/his duties.

h. Regional peer meetings for the beginning teachers in a particular geographical area are arranged twice per term. During these meetings they will, in a non-threatening atmosphere, share common problems and ideas.

i. A system of teacher self evaluations conducted by the beginning teachers, pupils' questionnaires, lesson observations and informal consultations between beginning teacher and mentor form a structure of in-school support.

j. Regular visits from the Induction Programme staff take place to ensure the smooth running of the programme in the schools.

k. Staff members from the university may on request visit their ex-students in their schools to discuss content related problems with them. Likewise, the beginning teachers get the opportunity to meet their former lecturers during workshops and seminars. Due to the small size of many schools in Lesotho, mentors often do not have the same subject specialization as the beginning teacher.

l. Beginning teachers, with the assistance of mentors, are issued with a fill-in School Information Booklet, which enables them to collect all relevant information about their schools immediately after taking up a teaching post.

m. A handbook is issued to the beginning teachers, containing relevant materials developed to support them in their work.

Components of the Induction Programme: The Mentor

When the beginning teacher has found employment at a school, and the principal has agreed to her participation, a mentor is identified. The mentor is preferably a teacher at the same school with some years experience, if possible teaching the same subjects as the beginning teacher or at least related subjects. The mentor will during special training workshops receive instruction in his/her role in helping the beginning teacher, and is considered a participant in the Induction Programme.

The mentor assists the beginning teacher in a variety of ways. Most important is that the mentor is available whenever the new teacher feels the need to discuss problems arising. The administering of the various evaluation methodologies described below, even though left with the beginning teachers, are expected to take place in close cooperation and dialogue with the mentors.

School Visits

The Induction Programme coordinator visits the beginning teachers regularly in their schools. During these visits, problems, which the beginning teacher and the mentor have failed to solve, or just want to discuss, are taken up. If the beginning teacher faces problems of a nature which calls for expertise from other members of the staff of the Science Education Department, the coordinator will assist in approaching the lecturer in question for a visit to the school and teacher concerned. During the induction year, a beginning teacher may receive roughly between 3 and 8 school visits (averaging 4.3), all depending on the degree of difficulties experienced in each case. Since no evaluation of the performance of the beginning teachers takes place during these visits, they can be conducted in a relaxed and conducive atmosphere, and in almost all cases they are welcome and highly rated in ensuing evaluations.

Peer Meetings

Once quarterly, the beginning teachers meet a regional centers, with 5 to 15 teachers attending each meeting. These peer meetings are very informal, with no fixed agenda, and the purpose is to give the novice teachers an opportunity to exchange experiences in a non-threatening atmosphere. No other persons are present during a peer meeting, but a mentor is normally asked to be around, so that the participants can call upon his expertise in particular cases arising from their discussions. Evaluations carried out amongst the peer meeting participants show a high appreciation of the meetings, in spite of some logistical problems experienced in convening them.

Seminars and Workshops

All beginning teachers and mentors are invited to participate in workshops which last for two or three days. Also principals are invited, but rarely turn up. An Introduction Seminar, in which the Induction Programme is explained, is held in July. In October and in January two Follow-up Workshops are held, in which the experiences of the teachers and the mentors during the Induction Year are discussed. Selected topics of interest for beginning teachers are presented as well. These can be of content related nature, or general educational issues, or of the kind that helps the new teacher to get acquainted with the overall
educational set-up in the country. In May or June, the last Seminar is held. This includes an evaluation of the Induction Year. Around this time, the Induction Programme is also introduced to the new graduates of the Science Education Department.

Experience has shown that both beginning teachers and mentors highly appreciate the opportunity given through the seminars and workshops to get together with colleagues for professional development as well as socially. The average participation rate is very high for a voluntary programme, normally between 80 and 90% of the invited teachers.

**Teacher Evaluation Methodologies**

A variety of methodologies has been developed to help the beginning teacher to get a picture of her own performance as perceived by herself and others, and to measure the progress made. Whereas the evaluation tools described below are designed for the Lesotho Induction Programme, two of them, the Diary and the Pupils’ Questionnaire are based on instruments originally designed by Vonk (1984) and used in the Netherlands.

**a. Teachers Self Evaluation—The Logbook**

This self evaluation instrument is designed for use over 2 teaching weeks once every 3 or 4 months. In the logbook, the beginning teacher will record what activities were planned for the lesson, the deviations from the plan and positive and negative experiences gained from the lesson. The entries in the logbook are then analyzed using a category system. This enables the teacher to identify strong and weak areas as well as to register any changes observed during the Induction Year.

Even though all beginning teachers appreciate the value of the logbooks, quite a few fail to put them into full use, due to the amount of time it takes them to work with this evaluation tool. Also the analysis categories may still be too complex. Some adjustments have been made to the original logbook format, but the same problem still prevails to some extent. Because of this a new **Teacher Self Evaluation Instrument** was developed in 1992. Experience so far seems to indicate that the latter tool, gives better results during the first few months of the Induction Year, while the Logbook stands a better chance of a high appreciation rate if introduced after 3-4 months’ teaching.

The mentors are trained to play an active role in helping the beginning teachers in using the above as tools for reflection.

**b. Pupils Evaluating the Teacher—The Pupils’ Questionnaire**

The mentor, on behalf of his protegee, administers this questionnaire with 10 students, selected at random, who are asked to respond to 20 statements about the teacher, all dealing with various aspects of teacher behavior in the classroom. The responses, which are given on a five point scale, are analyzed and categorized. This way the teacher can get an indication of how aspects within her teaching performance are perceived by the learners. The 20 statements are categorized into four areas:

- Communication skills, instructional skills, classroom management and teacher-pupil relations.

The pupils’ questionnaire presently in use, was developed together with a group of beginning teachers and mentors during a workshop. It is based on the original version, an adaptation from Vonk (1984) and new materials, kindly provided by Vonk during a visit to the programme in 1993. The workshop then adapted the material to the local situation, and a trial version was tested by the workshop participants before the final version was produced.

Both students (pupils) and teachers are in general appreciative of this evaluation tool, and the use of it often spreads to other teachers in the school, when they get the wind of what is going on. Mentors are being trained in ways of providing feed-back to the beginning teachers based on the analysis of the questionnaires.

**c. Lesson Observations**

The third way in which the beginning teacher can get useful feedback on her teaching, is by using lesson observations. In most cases, it is the mentor who observes. During special mentor training workshops and in programme seminars, mentors and beginning teachers are given instructions in the way these observations can be planned and conducted in order to serve their purpose. Models of Clinical Supervision are introduced, and a non-threatening, result-oriented approach is always emphasized.

**Conclusion**

After four years of operation, the Induction Programme has become fully accepted in the schools all over the country. It is in regular contact with the Ministry of Education and often calls upon its civil servants to assist in presenting topics of interest to the participants during the seminar. The Association of
Headmasters and Headmistresses follows the development of the programme with interest and appreciation.

Ongoing evaluations more than indicate that beginning teachers taking part in the Induction Programme have an easier and therefore more successful first year of teaching than they would otherwise have had. There is less possibility of disenchantment resulting in a negative attitude to teaching or resignation. Experience so far seems to suggest that the retention rate amongst the Science and Mathematics teachers has grown considerably during the life span of the Induction Programme. In fact that the Ministry of Education in Lesotho has officially requested the National University to extend the programme activities to encompass novice teachers in all subjects is significant as an indicator of achievement. Thus the aim of getting better and longer serving Science and Mathematics teachers to the benefit of the secondary and high school learners in the schools of Lesotho is seen to be achieved. Yet much is dependent on developments in South Africa. For example, if wages in South Africa (for all kinds of alternative jobs) remain considerably higher, it will still be difficult to retain teachers. If South Africa would rapidly increase spending on black education, it might well hire away the better trained Lesotho teachers. In the latter scenario they would be retained in the profession though not in Lesotho.

References

INFORMAL SCIENCE TEACHER PREPARATION

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Introduction

As traditional United States teacher preparation programs are being challenged, museums and science centers are gaining recognition as alternative training environments. Gardner, in his book The Unschooled Mind (1991) claims that “museums have retained the potential to engage students, to teach them, to stimulate their understandings, and, most important, to help them assume responsibility for their own future learning.” In a review of the research on museums as science learning environments, Ramey-Gasser, Walberg III and Walberg concluded that, “Indeed, informal learning environments such as zoos, natural history and cultural museums, and science centers have the potential to captivate and arouse interest, motivate learning, and allow students to build connected knowledge through meaningful experiences” (1993, p. 20).

Additionally, recognition is growing that museum educators are “specialists in developing and presenting exciting educational experiences that engage the learner in exploration and discovery” (Mintz, 1992).

Questions Guiding the Study

- How would the improvement, if any, be judged for the preservice elementary teachers in this pilot, with the myriad of changed variables over the university setting with a single university professor?

The Problem

The purpose of this descriptive study was to determine the effects of conducting a university elementary science methods course at a science center on the attitude toward teaching science of a sample of preservice teachers.

To explore the problem and focus on improving preservice teacher preparation, Duquesne University and The Carnegie Science Center developed a collaborative effort to move instruction for selected elementary science methods courses from the university to the new, $40 million Carnegie Science Center. The methods course would be offered in the science center setting using the varied resource and educational opportunities and taught by qualified science center educators. The pilot project hoped to take advantage of the suggested affective impact of science center settings. The partnership also responds to the clarion call for collaborative efforts which result in systemic change in the nation’s educational system (Smith & O’Day, 1990; Lund & Wild, 1993).

The Importance

There is growing exploration around the country in science center/university collaboratives to improve undergraduate and graduate level instruction in elementary science methods courses (Anderson, 1993). The Duquesne University/Carnegie Science Center pilot, if shown to have positive affects on preservice teachers’ attitudes, could serve as a model for other university/science center collaboratives as a viable model. Productive models of many forms which fit the resources of the different communities are needed in the national effort to improve the preparation of elementary teachers in the area of science teaching.
Literature Review

The problem being explored, that of improving attitudes toward science teaching among preservice teachers using science center resources, requires an investigation in two areas. This dual approach is necessary as the project is focused on identifying a problem and relationship in the formal education domain and seeking methods to improve the situation through informal education resources. Herein lies the powerful potential in finding new ways to deal with old problems through new collaborators which bring together the formal and informal education players.

The first area of research is in the relationship between attitudes toward science and science education and teaching efficacy. Science teaching efficacy is defined as a teacher's belief that the or she has the ability to teach science effectively and to affect student achievement (Riggs, 1988).

The second is in the area of affective impact, especially in teacher preparation, in science centers and museums. Affect is identified as part of Benjamin Bloom's "taxonomy of educational objectives" and relates to feelings, emotions, attitudes and values (Roberts, 1990).

Importance of Science Attitudes in Elementary Teachers

Koballa and Crawley state, "there is widespread consensus that the term attitude toward science should be used to refer to a general and enduring positive or negative feeling about science" (1985, p. 223). In the same work, the authors state that "The assumptions that students will acquire positive attitudes toward science as they learn more science facts is no longer valid" (1985, p. 222). This position has widespread support, including the work of Piel and Green which leads them to suggest that it is impractical to address elementary teacher competence in science through added coursework before appropriate attitude adjustment process have been planned and implemented (1992).

Westerback reports, in a review of the research, that there appears to be agreement that negative attitudes toward science and teaching science are commonplace among elementary teachers, leading to avoidance of teaching science, passing negative attitudes on to students and interference with the learning process (1982).

If negative attitudes impede the subsequent effectiveness of elementary teachers in the areas of science, there is research to suggest that the logical corollary is supported. Ramey-Gassert concluded from her study that personal science teaching efficacy among elementary teachers correlates positively with attitude toward science, and with choosing to teach science (1993).

While it may not be possible to predict that positive attitudes among preservice teachers toward science result in more effective teaching (Koballa, 1986), the research supports the position that a positive attitude toward science is one of the critical prerequisites to the potential of effective science teaching by the preservice teacher.

Affective Impact of Science Centers and Museums

What is the special nature of a science center or museum? Some in the field of education suggest that, "Science museums are unequaled in the affective realm, able to excite curiosity and motivate learners. They can substantially increase the number of students 'turned-on' to science" (Mintz, 1992, p. 3). Yet, while attitude has been carefully researched in the formal education domain, there is no equivalent research base in the informal education field. Research efforts often deal with the affective domain of learning. Roberts reports that "It is the nature of our institutions—multisensory, three-dimensional, interactive—that they should appeal so strongly to that part of the brain concerned with space, image, affect" (1990, p. 19).

Affect is often considered as having an number of components, including attitude (Anderson & Roe, 1993). Additionally, museums and science centers have a wide array of focal points for visitor experiences, including exhibits, programs, interaction with, and observation of, live animals, and general overall experiences for the child, adult, family, teacher and school group. Research that is done often focuses on the impact and attitudinal response from a particular interactive exhibit or interactive space (Borun, 1989; White, 1990; Perry, 1993; Anderson & Roe, 1993).

Within the informal education field, one of the numerous challenges to research is attributed to the differing opinions of the goals of informal education. Target areas in informal education include informing and educating, knowledge gains or conceptual understanding, and perceptions and attitudes, with it being recognized that there are difficulties in measuring changes in the affective domain (Crane, 1994).

In a review of literature, Roberts assess the dilemma as such:
The role of affective modes of knowing in learning processes remains an elusive, fragmented area of study. Not only does research cross many disciplinary boundaries, but language about affect changes from one individual to the next. Literature searches and discussions with a variety of academic and museum professionals reveal frustratingly little work on "affective learning" per se. (1990, p. 19)

However, there have been a number of descriptive studies which have found positive attitudinal changes from science center experiences in field trips (Prather, 1989; Bitgood, 1993), student experiences (Tuckey, 1992), and teacher activities (Leroux, 1989; Anderson, 1993). Other studies have findings which suggest positive affective and attitudinal impact of science center or museum experiences, such as Bloom's research into science career choices of girls and minorities (1985).

More specific research into the affective impact of science centers would be obviously helpful as informal education resources are looked to play a larger role in the educational reform effort. Existing research, descriptive studies, and popular opinion suggest that a powerful potential does exist. Anderson and Roe probably best stated it with the point that, "A little-understood concept—and a hope of many of us—is that museum and science centers make real impressions on lifelong learning" (1993, p. 9).

It is hoped that the descriptive study presented in this report takes one small step forward in building a greater understanding of the impact science centers can have on the improvement of elementary teacher preparation for enhanced science learning of all children.

Method

Design of The Elementary Science Methods Course
The pilot elementary methods course was designed with several key features distinguishing it from more traditional methods courses:
Hands-on activities—The course design focused on the preservice teachers engaging in, and then conducting, hands-on activities using pedagogical approaches such as inquiry learning and guided discovery. Exposure was provided to a wide variety of activity resources, ranging from inexpensive, supplemental materials such as AIMS and GEMS modules to more comprehensive packages such as Science & Technology for Children.

Science center observations—Observations time was required of all preservice teachers. Each participant could choose science center spaces and/or activities of interest where children engaged in free choice science activities. Primary spaces included exhibit halls, Ports of Discovery which included two hands-on spaces with discovery boxes, age appropriate exhibits, water tables and live animals, and science center children's classes.

Variety of course instructors and guest teacher—Course instructors were science center educators with master's degrees in education whose position involved an emphasis on hands-on science experiences and professional development of teachers. Lead instructors also had classroom experience. A number of staff educators and scientists were engaged as guest instructors in areas of their particular interest, such as live animals, the science center's weather service, or the live pacific coral reef aquarium. Attention was given to providing female role models for the predominantly female preservice teacher population.

To accommodate the changes in instructional strategy, the university's usual two day per week, 1-1/2 hour/class format was changed to a once per week, three hour format conducted at the science center facilities (a combination of the new facility and the educational annex) three miles from the university campus. Students had to provide their own transportation, but were provided free parking. This study reports the findings of the first three sessions of the course: Fall 1992, Spring 1993, and Fall 1993.

As in all developing courses, certain individual sessions and course features worked better than others. Adjustments were made in the syllabus and the assignments from semester to semester. However, the basic elements of a hands-on activity approach, use of qualified and enthusiastic science center staff, and integration of science center resources and observation experiences remained constant. A female staff member was added for the third session as an instructor to complement the original two male lead instructors.

Determining Course Effectiveness
The various features of a preservice course at a science center would be deemed successful if the students demonstrated an improvement in their attitudes towards teaching science. The survey results were collaborated with weekly journals to
provide a more qualitative response regarding the preservice teachers’ experiences and attitudes as they progressed through the one semester, three credit course.

Student Enrollment
There was no effort made to enroll select students in the Elementary Science Methods course. The vast majority of the students were taking the course in their junior year prior to student teaching. The course was to be noted in the college catalog as being taught at the science center, which was done for the first and third sessions, but not for the second one. The students in that course were only informed on the first day of class that the remainder of the course would be instructed at the science center. In the first and third sessions the students had the option of selecting a traditional elementary science methods course on campus.

The Instrument
The instrument chosen was the Revised Science Attitude Scale, revised from the original developed in 1974, and recommended as a “reasonably valid and reliable scale ready for use in comparing treatment effects of groups of preservice teachers toward the attitude object of teaching science” (Thompson & Shrigley, 1986, p. 342).

This 22-item Likert scale instrument (see Appendix A) was used to assess the attitude of the participating preservice teachers toward science. The Science Attitude Scale uses a five choice scale which the developers identify as having four subcomponents: Comfort-discomfort (9 items); Need (5 items); Time (3 items); and Equipment (5 items). The developers report that examining data for correlation between the four subcomponents suggested a “moderate interrelatedness and at the same time an independence of the four subcomponents. The former verifies a single subject; the latter suggests four subcomponents” (Thompson & Shrigley, 1986, p. 336). Previous research by the developers indicated that the reliability (Cronbach’s coefficient alpha) for the total attitude scale is 0.91 (Shrigley, 1974).

The 22 questions from the Revised Science Attitude Scale were left unaltered, but imbedded intact among other questions regarding background and assessment techniques used in the course.

An additional qualitative approach was taken through the use of journals. Weekly questions were presented to the participants which they responded to in their journals. The open ended questions provided an opportunity to explore the factors in antecedent experiences which might have contributed to attitudes brought to the course, as well as reveal insights into what factors during the course may have had an impact on attitudes as measured at the end.

Procedure
The attitude survey was administered during three consecutive sessions of the elementary methods course taught at the science center during the 1992 Fall, the 1993 Spring and 1993 Fall sessions. The preservice teachers were administered the attitude survey at the start of the first session of the course by a science center staff member without the course instructors present. Names were not given, but student numbers were written on an attached piece of paper. The surveys were taken by the staff member and filed without the instructors seeing them. The procedure was repeated on the last day of the course. The surveys were then compared to make sure there was a matching and post-course response sheet. Those without matches were not included in the results.

The journals were reviewed periodically during each course and at the end of the course. With the purpose of this study focused on the attitude results, and due to time constraints, the journals were not systematically evaluated. However, they were all read for comments which related to attitude to identify particularly informative comments or case studies which might shed light onto qualitative elements related to the survey results. No further analysis on the qualitative nature of the responses was done. Students were asked permission to quote passages with the understanding that their names would be kept confidential.

Results

Attitude Survey
The student pre-and post-responses from the three sessions were combined to yield a sample size of 48. The design of the survey suggests that it relates to one construct and the data was analyzed on a summed response to the 22 questions. Responses were given on a Likert scale with Strongly Agree given a value of 1 and Strongly Disagree a value of 5. Since statements were posed in both the positive and negative, the negative responses were converted by subtracting from 6.

The scores were combined for all the students and a precourse and postcourse mean calculated, as well as separate precourse and postcourse means per session, as shown in Table 1.
Table 1.
Means of Attitude Toward Science Teaching Using Shrigley & Thompson's Revised Science Attitude Scale for Fall 1992, Spring 1993 and Fall 1993

<table>
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<th>Precourse</th>
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<td>Combined results</td>
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<td>Mean</td>
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<td>Mean</td>
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<td>Spring 1993</td>
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<td>n</td>
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<td>22</td>
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<tr>
<td>Mean</td>
<td>56.6</td>
<td>43.4</td>
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<td>Fall 1993</td>
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<tr>
<td>Mean</td>
<td>47.9</td>
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The results of this descriptive study indicate that for the three sessions of the Elementary Science Methods course taught at The Carnegie Science Center, the preservice teachers' attitudes toward teaching science changed in a positive direction.

Journal Entries
In addition, a review of the weekly journals revealed numerous accounts of changes in attitude, increased confidence in teaching science, and a desire to make science interesting for their future students. The following quotes are selections from student journals.

Student One. To the first question of the course to relate her past experiences in science education she wrote:

I distinctly remember my seventh grade science class—a constant barrage of boring, meaningless lecture. I think my final grade was a C or D. My next notable science experience was in the 10th grade with a woman I admired. I remember I liked her, but, again, science or biology didn’t interest me. I had already been convinced I was stupid.

To a question near the middle of the course, she wrote:

We need to erase or stop putting the idea in kids (sic) heads that only a few can do science. I like this science class and it has changed my perspective. I was amazed over at the Science Center.

To the final question of the semester which was to reflect on this course, her response was:

Well, my attitude towards science has changed. I feel as though I would be able to teach science. I need more information. I basically lack the theory of many sciences, but have discovered that I can learn them. . . . I enjoyed my experience at The Carnegie. I am a hands on learner and the methods used in this course made science available to me for the first time. I helped my self esteem. I actually succeeded in this course with little difficulty. I have told all my friends about the course. . . . Whether or not the science is made available to students will depend on me and not the book. I feel as though I’ll be able to offer the possibility of success to my students.

Student Two. “This course has enabled me to feel comfortable with scientific hands-on approaches. I no longer fear doing experiments alongside my students. I’ve learned how the process is just as important as the product, if not more.”

Student Three. To the question “What have we done so far that has positively impacted your thinking and feeling about science education?”, this student responded:

What haven’t you done so far that has positively impacted my thinking and feeling about science education? Most important, everything we are doing in this class is interesting and relates to all of us in one way or another. We are each taking part in learning about science—this is the key to being interested in science and in turn developing a positive (sic) about the subject of Science itself. Unfortunately, my science education consisted of being drilled with facts and numbers and tests! The only experiments I can remember doing consisted of following a step by step procedure you had to follow word for word. This did not allow the exploration and creativity; as a result, I never liked science. This science class allows me to return to my elementary days and relearn everything I didn’t learn and most importantly—to have a ton of fun at the same time!
Discussion

The attitude surveys and journals indicate that there is an overall ability of the course to improve preservice teacher attitudes toward science teaching. Comparing the results per session, combined with student journal entries offer further insights.

Preservice teachers in the first session, Fall 1992, started with the most overall positive attitudes toward science teaching and displayed the smallest positive gain in attitude. It suggests that with the extra explanation regarding the course which took place at the university, there may have been more conscious selection by the students to take the science center methods course if they were more positive toward science. Student journal and verbal comments during the sessions revealed that the drive to the science center and the need to find parking were significant issues in the minds of many of them. Enough so, that given an opportunity, students who did not consider the science center course as a positive option, chose to take the traditional course on campus.

This natural selection process is further supported by analyzing the results from the Spring 1993 session. Due to an error in the written course information, more preservice teachers were unaware when they registered for the course that it would be taught at the science center. The initial attitude survey indicated that this group had the least overall positive attitude toward teaching science and displayed the most significant gain. The indication is that this group was more indicative of the general elementary education majors on campus and that attitude gains would be more significant among all the sessions if there was a blind registration process between the science center and university options.

Students cited numerous experiences in their journals which indicated an impact on their attitudes through many features of the course, with the three major components all cited—the hands-on focus, the enthusiasm and modeling of the instructors, and the resources of the center.

Questions for further research

- What features of the science center course contributed the most to the preservice teachers’ improvement in attitude?
- Could the course be replicated elsewhere, even on campus, with the same results?
- What are the attitude improvements with similar methods courses being experimented with at other science centers?
- Will the attitude changes last over time and yield more actual hands-on teaching when the preservice teachers teach their own students?
- Will they use informal education resources, like the science center, in their students’ learning experiences?

Conclusion

Since many studies indicate that there are positive gains possible in preservice teacher attitudes toward science through a variety of approaches (Westerback, 1982; Ramey-Gassert, 1993), it cannot be said that the science center course option was an improvement over the regular university offering. However, the methods course as developed and taught at The Carnegie Science Center clearly was successful in improving the attitudes toward science of the preservice teachers who participated in the three sessions.

The science center methods course should be maintained and is worthy of consideration for modeling where other science center/university collaborations are possible.

References


The American Psychological Association, in conjunction with the Mid-Continent Regional Educational Laboratory (McREL), have recently completed an exhaustive review of the research base resulting in the identification of 12 key factors (principles) that positively effect learning for all students.

Using these 12 findings, summarized below, they are now developing a battery of assessments which measure (a) teachers' assumptions and beliefs about learners, learning, and teaching; and (b) teachers' perceived classroom behaviors. In addition to these instruments, two companion scales assess student perceptions of their teachers' classroom practices and their administrators' perceptions of school practices, in relation to the "Learner-Centered Principles."

The model is based on the premise that teacher behaviors and practices are a function of (a) their beliefs and assumptions about learners, learning, and teaching, (b) administrative policies, practices, and resulting school culture. In turn, teacher behaviors and practices directly impact student motivation, achievement, and learning outcomes.

This battery of instruments will enable teachers to examine their own teaching beliefs and strategies in order to facilitate positive changes, provide specific information on how to most effectively impact individual students, and identify needed areas of personal staff development. In addition, this component of the project will help set the stage for systemic change by engaging students, teachers, and administrators in the reform process.

Five factors with 12 underlying principles were identified as critical to effective learning. These are: **Meta-cognitive and Cognitive Factors**: Principle 1: *The nature of the learning process*. Learning is a natural process of pursuing personally meaningful goals, and it is active, volitional, and internally mediated. Principle 2: *Goals of the learning process*. The learner seeks to create meaningful, coherent representations of knowledge regardless of the quality of data available. Principle 3: *The construction of knowledge*. The learner links new information with existing and future-oriented knowledge in uniquely meaningful ways. Principle 4: *Higher order thinking*. Higher-order strategies for "thinking about thinking"—for overseeing and monitoring mental operations—facilitate creative and critical thinking and the development of expertise. **Affective Factors**: Principle 5: *Motivational influences on learning*. The depth and breadth of information processed, and what and how much is learned and remembered, are influenced by (a) beliefs about personal control; (b) saliency of personal values, interests, and goals; (c) personal expectations of success or failure; (d) affect, emotion, and general states of mind; and (e) the resulting motivation to learn. Principle 6: *Intrinsic motivation to learn*. Individuals are naturally curious and enjoy learning, but intense negative cognitions and emotions (e.g., feeling insecure, worrying about failure, etc.) thwart this enthusiasm. Principle 7: *Characteristics of motivation-enhancing learning tasks*. Curiosity, creativity, and higher-order thinking are stimulated by relevant, authentic learning tasks of optimal difficulty and novelty for each student. **Developmental Factors**: Principle 8: *Developmental constraints and opportunities*. Individuals progress through stages of physical, intellectual, emotional, and social development that are a function of unique genetic and environmental factors. **Personal and Social Factors**: Principle 9: *Social and cultural diversity*. Learning is facilitated by social interactions and communication with others in flexible, diverse (in age, culture, family background, etc.), and adaptive instructional settings. Principle 10: *Social acceptance self-esteem, and learning*. Learning and self-esteem are heighted when individuals are in respectful and caring communities.

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Science Education International, Vol. 5, No. 2 June 1994
relationships with others who see their potential, genuinely appreciate their unique talents, and accept them as individuals. **Individual Differences:**

**Principle 11**: Individual differences in learning.

Although basic principles of learning, motivation, and effective instruction apply to all learners (regardless of ethnicity, race, gender, physical ability, religion, or socioeconomic status), learners have different capabilities and preferences for learning mode and strategies. **Principle 12**: Cognitive filters. Personal beliefs, thoughts, and understandings result from prior learning and interpretations become the individual's basis for constructing reality and interpreting life experiences.

For additional information, contact:

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SCIENCE EDUCATION PARTNERSHIPS: MANUAL FOR SCIENTISTS AND K-12 TEACHERS
by Chris Deeter

'The way we usually market education innovation leaves little room for enlisting the power of teachers or providing for a continuing relationship between schools and universities. Teachers are typically confined to their classrooms with schedules that preclude significant interaction with other educational professionals," so writes Bruce M. Alberts, Ph.D. and president of the National Academy of Sciences in this new publication edited by Art Sussman. This book is must reading for anyone at all interested in changing the paradigms of traditional science education.

Art Sussman, former director of the UCSF Science and Health Education Partnership and current director of the Far West Regional Consortium for Science and Mathematics Education, has collected numerous articles that clearly and concisely explain the development and advantages of teacher/scientist partnerships in education. The book is divided into five units of emphasis: Introduction, Teacher Centered Activities, Student Centered Activities, Evaluation and Resources, and The Big Picture.

A true highlight of the book is A 10 Step Recipe for Starting a Partnership Program. This article provides answers to many of the most pressing questions as one begins to develop partnerships between school districts and scientists. Throughout the teacher centered activity section are ideas for initiating and planning partnerships. These partnerships include summer work positions for teachers, joint summer research expeditions, innovative summer workshops, and experiments with constructivist teaching in science education. The student centered section contains articles on attracting underrepresented minorities to mathematics and science disciplines, health and medical partnerships with local medical and dental colleges to provide the students information about dental health and physical and mental maturation, and contests designed to allow students to write their own lesson plans. The task of evaluating these innovative programs is discussed with the difficult reality that the old paradigm of evaluation must be replaced with a newer more flexible one. The evaluation articles are followed by four articles meant to provide suggestions for some realistic ways to fund these partnerships.

The rewards and benefits of these partnerships emphasize that although the vast majority of this book deals with partnerships based on the West Coast, the partnership idea is one which must be pursued worldwide.

This book can serve as a great resource guide for anyone who is presently considering the development of a scientist/teacher partnership. It is also a refreshing way to introduce new ideas into a working teacher scientist relationship.

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INARTICULATE SCIENCE?

Perspectives on the Public Understanding of Science and Some Implications for Science Education

by
David Layton, Edgar Jenkins, Sally Macgill, & Angela Davey

The public understanding of science is a matter of concern in most countries. This is not simply because educators or scientists wish to promote a wider understanding of scientific ideas as worthy of the attention of all thinking citizens. Such understanding is commonly regarded as essential for the effective implementation of a wide range of social, economic, technological, medical, employment or other policies which have a scientific dimension. This book explores the ambiguities and limitations of the concept of 'public understanding of science' and, by means of case studies, addresses the meanings and social uses which science has for members of the adult public who are not themselves professional scientists. Drawing upon a substantial literature to place the case studies in a broader context, the final chapter examines the implications of the research for science education.

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Published by Studies in Education Ltd., Nafferton, Driffield, YO25 0JL, UK

POLICY, PRACTICE AND PROFESSIONAL JUDGEMENT: SCHOOL-BASED ASSESSMENT OF PRACTICAL SCIENCE

by
J. F. Donnelly, A. S. Buchan, E. W. Jenkins, & A. G. Welford

Practical work has had an important place in British science education for many decades. However, it was only in 1988, with the advent of the science examinations occurring at the end of compulsory schooling. The innovation was welcomed by many science teachers, but it was also seen as the problematic part of the new examination in science. The study reported in this book involved an in-depth examination of the implementation of this policy. It took place between 1990 and 1992, and involved extensive fieldwork in schools together with a national questionnaire. The findings raise important issues, both about the role of practical work and its assessment in the curriculum, and about how policy decisions in education are taken and implemented. Those issues are of increasing significance as science education practice becomes even more subject to centralized control in the context of the National Curriculum.

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THE HARARE GENERATOR—INNOVATIVE IDEAS AND TECHNIQUES FOR SCIENCE EDUCATION IN AFRICA

by Knapp Hill

A package of materials is now available from ICASE Publications offices representing the output from the Harare Generator, held in Harare, Zimbabwe in 1991.

The Harare Generator was not a conference in the conventional sense, but rather an event bringing together African science educators and other resource persons to share experiences and generate new ideas for science teaching and teacher education. The package of materials consists of a book describing the event itself and also ways in which it
could become a catalyst in the on-going process of regenerating science education in Africa and elsewhere. But, the major part of the book describes the experiences and outcomes of 18 group projects and suggests various ways in which these could be used in pre- and in-service teacher education.

There are two sets of colour slides, one showing the concept of the Harare Generator, the other illustrates various innovative approaches to science education being developed with students during the meeting. And there is a three-hour video tape made up of classroom scenes and interviews with teachers and students to illustrate various techniques.

The cost of the components of the package are as follows:

- Book (260 pages) $10.00 (£7.25)
- Slide set A (60 slides 35mm) $20.00 (£15.00)
- Slide set B (60 slides) $20.00 (£15.00)
- Videotape $20.00 (£15.00)
- Postage and packing add 50%

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The result of this work was an integrated system designed for large scale, low cost operations, including: equipment, written materials, transportation and administration.

The equipment itself takes the form of a type of highly compact science exhibit, consisting of 11 multi-activity workstations for pupils to explore. A range of these exhibits were developed, each set focusing on one basic science topic. Schools keep the exhibit for, on average, two days.

A schools service incorporating this system began in January 1993 in London. During its year it served some 120,000 pupils at an approximate cost of £0.30 per pupil. This year it is on target to reach 220,000 pupils at a cost of £0.25 per pupil, and is operating in many areas of the UK outside London.

Teachers especially like the service because it offers small schools access to resources which would otherwise either be too expensive to buy or too difficult to produce for themselves. Pupils gain valuable additional learning experiences which compliment their class teacher’s work without disrupting or over-burdening him/her.

A further significant feature of the SchoolWorks approach is that it can reach pupils regardless of gender, ability, social background or location.

SchoolWorks is part of a non-profit organisation called Science Projects based in London, UK. Science Projects is keen to work with educators in other countries interested in setting up operations of this kind.

For additional information contact: Peter Trevitt, Science Projects Limited, 20st. James Street, Hammersmith, London, W6 9RW.
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Location: London, UK
Contact: LIYSF, PO Box 159, London SW10 9QX, UK
The Science Forum is the principal meeting in Britain of young scientists. Over three hundred students attend from some fifty nations to make this an international event of major significance. The program features lectures, seminars and demonstrations from leading scientific names, and an extensive range of visits to university and industrial research establishments.

August 8–12
**13th International Conference on Chemical Education**
Location: San Juan, Puerto Rico
Contact: Ram S. Lamba, Chairman 13th ICCE, Inter American University of Puerto Rico, PO Box 191293, San Juan PR 00919-1293
This will be the first time that an ICCE meeting will have been held in the Caribbean Region. The objective of this conference is to bring together chemistry teachers from the pre-college and college levels to share ideas and learn from each other about innovations in the teaching and learning of chemistry. The theme is ‘Chemistry: The Key to the Future.’

August 21–27, 1994
**15th Biennial Conference of the Asian Association for Biology Education**
First Circular
Location: The Conference will convene at the Art Hall of Tokyo Gakugei University, Koganei, Tokyo
Contact: Secretariat: Secretariat, 15th AABE Conference c/o Department of Biology Tokyo Gakugei University Koganei, Tokyo 184, JAPAN
Fax: (81)-423-24-9832 (to H. Kitano or N. Katayama)
Tel: (81)-423-25-2111, ext. 2674 (to N. Katayama)
The special theme for the 15th AABE Conference is “Biology Teaching to Non-biology Majors.” It will enable a focus to be made on the content, methods, approaches and outcomes required in biology programs designed for students who do not intend becoming biology majors or biology specialists. There will also be time allocated for the usual country reports. General sessions will cover all aspects of biology education, and will be grouped as far as possible according to themes.

September 24–29, 1994
**WOCATE Conference**
Sponsored by the World Council of Associations for Technology Education
Location: the University of Banská Bystrica, Slovak Republic
Contact: WOCATE Secretariat, Mrs. Doris Traberth, Schlosserstrasse 9, 99084 Erfurt, Germany
The conference is meant to discuss various aspects of innovation, production, small scale industry management and education. Especially those projects developed by companies that bring technology education, economy and management closer to young people. The possibilities for transferring special experiences in school-industry-link projects will be discussed.

December 6–10, 1994
**The 9th ICASE Asian Symposium**
Location: Bangkok, Thailand
Contact: Dr. Janchai Yingprayoon, Secretariat: IPST Sukhumvit Rd. Ekamai, Bangkok 10110 E-mail: OICST@CHULKN.CHULA.AC.TH
The theme of the symposium is “INCREASING THE EFFECTIVENESS OF SCIENCE TEACHING IN THE CLASSROOM: A CHALLENGE FOR SCIENTIFIC AND TECHNOLOGICAL LITERACY FOR ALL.”

January 5th–7th, 1995
**The Association for Science Education Annual Convention**
Location: The University of Lancaster, UK (which is 200+ miles north of London)
Contact: Dr. David S. Moore, General Secretary, College Lane, Hatfield, Herts. AL10 9AA

September 24–29, 1995
**CONASTA 44**
Location: Brisbane, Queensland, Australia
Contact: David Tulip, Centre for Mathematics and Science Education, Locked Bag No. 2, Red Hill, Queensland, Australia. E-mail: D.Tulip@qut.edu.au
Extending and Improving Education in Science for All Children and Youth by Assisting Member Association Throughout the World

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Science Education International is the Quarterly Journal of the International Council of Associations for Science Education. ICASE was established in 1973 to extend and improve education in science for all children and youth by assisting member associations throughout the world.

This journal provides a means for associations, institutions, centres, foundations, companies and individuals concerned with science education, to share perspectives, concerns, ideas, and information which will foster cooperative efforts to improve science education, and which will serve as a chronicle of the advancement of science education throughout the world.

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ICASE News and Briefs
ICASE Welcomes New Members 2
Young Reports for the Environment Meeting
International Conference for Science and Technology and Mathematics Education 4
Report from the Nordic Representatives of the INISTE/UNESCO Meeting 5
Latin American Association for Science Education
Report of the 1994 Dortmund Summer Symposium 7

Feature Article
Scientific & Technological Literacy for All—The Role of Educators 10

Science Education Around the World
Can Today's Science Education Practices Succeed in 21st Century Pakistan? 17
Science Education in New Zealand
Some Issues and Problems Related to Science Teacher Education Programs In Korea 22

Research on Curriculum, Teaching & Learning
Narrative and Scientific Literacy 25

Teaching Materials & Strategies
Pre-Science Experience Kit (PEK) 27

Science Teacher Education & Leadership
Back To(?)... or Forward Past (!)... The Basics of Teaching? 30

Non-formal & Informal Science Education
Mobile Museum Launched in Luxembourg 34

Resources
Calendar 36

1

Science Education International, Vol. 5, No. 3 September 1994
ICASE WELCOMES NEW MEMBERS

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Canterbury Christ Church College
A New ICASE Institutional Member

Canterbury Christ Church is a College in the University Sector with a long history of expertise in in-service education and significant fund of international experience.

The Science Department has expertise in both Biological and Physical sciences to Ph.D. level. It is a National leader in Science and Technology Education for primary teachers by distance learning techniques, with courses at Certificate, Diploma and Masters levels.
The Department is undertaking research into communication styles in text-based learning materials.
The Science staff have been responsible for the development and implementation of a major in-service science training programme for primary school teachers, 'Success with Primary Science', which has been used by Education authorities throughout the United Kingdom. A key feature of the developments pioneered at Canterbury has been the initiation and encouragement of locally tutored courses using the materials developed by the college staff and backed up by the College.
The Science staff have unparalleled experience in delivering flexible learning programmes in the United Kingdom and are uniquely qualified to assist the development of courses overseas, having had practical experience in the Middle East, Indonesia, Africa, the Caribbean, North and South America.

If your country needs teachers with an awareness of
• core concepts in science,
• scientific skills
• effective ways of teaching and learning science;
then Canterbury Christ Church College can, in a cost effective way:
• provide core course materials which can be adjusted to suit local conditions thus giving local "ownership";
• provide tutor support materials to assist effective delivery;
• provide an in-country consultancy service to promote local writing workshops;
• train those responsible for course delivery in our intensive residential workshops in the U.K. at Canterbury, or in the home country.
We don’t just supply a ‘whole course,’ but rather we help your trainers to develop a programme ‘custom-made’ for your country’s needs.

Christ Church College is situated in the historic City of Canterbury, a place of pilgrimage for travellers world-wide. Canterbury is in the South East of England, only 96 kilometres from London with good communications in the U.K., and with the Continent, being only 30 minutes from the Channel Tunnel.

For more information contact:
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YOUNG REPORTS FOR THE ENVIRONMENT MEETING
JUNE 19-20, LUXEMBOURG

Jack Holbrook
Executive Secretary, ICASE

On Sunday 19th June national operators of “Young reporters for the environment” met for the first time to launch the project on a European scale. The agenda covered strengthening the national structures and strategies, defining the mission topics, communication circuits for 1994-5 and agreeing the precise calendar of the project.

Present in the meeting were representatives from Denmark, France, Greece, Germany, Ireland, Portugal and Romania. The meeting was chaired by Philippe Saugier the charge de mission and European coordinator for the project, operating under the Foundation of Environmental Education in Europe (FEEE). From the discussions it appeared that the use of e-mail, a fundamental component of the operation, was problematic in many cases and ways were explored for getting schools to utilise this facility. The expectation was that this problem would be less severe in the future as more and more schools acquired modems.

Much interest was shown in the missions being proposed to which one student from each country would be invited to participate. Problems were discussed related to timing of the missions so that they did not clash with examination programmes etc within the European countries. It was anticipated that a mission would get good support even if the systems in some countries meant that they could not participate in all.

Ways of encouraging schools in more countries to participate in the “Young Reporters for the Environment” were explored and the models by which the project could operate within a given country were discussed. It was felt that science teacher associations could play an important role especially if they linked with groups having access to financial sponsorship.

The 20th June was seen as a very important working day for the future of the project and was held in the Luxembourg headquarters of the Commission of European Communities. The objective of the meeting was to evaluate the potential of the Young Reports project to encompass different levels of society—a fundamental issue for an innovative project that expects to reach the general public through intensive actions within the school community.

Following greetings, an introduction was provided by M. Ole Lovig Simonsen, President of FEEE and a deputy in the Danish parliament. Thomas Joly gave an overall picture of the Young Reporters project and Philippe Saugier expanded on this and explained the current position. Comments and other aspects were provided by a small group of ‘experts’ invited to the meeting giving the project more perspective and allowing FEEE to appreciate the value of the “Young Reporters for the Environment” approach.

Philippe Saugier in his presentation explained that the Young Reporters is a network of secondary schools covering the whole of geographical Europe, involving students in the 14-20 year age range. Like a specialised press agency, students are involved in initiating field inquiries about topics involving scientific research and the environment to write journalistic articles and then exchange and debate these articles with other young reporters of the network before diffusing this to the local, national and international public. In so doing Young Reporters strives to:

- improve students’ about important environmental issues
- bringing about changes of behaviour with respect to the environment
- enable students to feel more involved in the educational process
- encourage teaching through issues which confront society
• direct students to confront issues in a real life context and make contact with persons involved
• enable student groups to communicate with other groups beyond national borders
• address the general public with a new perspective that shows the capacity of youth to perceive and communicate about crucial environmental issues in a scientific manner.

For more information contact Philippe Saugier, FEEE, Ecole, 74130 Brison, France.

INTERNATIONAL CONFERENCE FOR SCIENCE AND TECHNOLOGY AND MATHEMATICS EDUCATION

An African regional conference on Learning for Life was held in the University of Botswana from 27 June to 1 July 1994. It was attended by more than 100 participants from 12 African Commonwealth countries and Mozambique as well as from Britain, Cyprus and the Bahamas. The Conference was sponsored and hosted by the Ministry of Education of the Government of Botswana and co-sponsored by the Commonwealth Secretariat, CASTME, UNESCO, and ICASE.

The meeting was opened by the Minister of Education for Botswana, The Hon. M. R. Molomo and the Vice-Chancellor of the University of Botswana, Prof. T. Thou. The Founder President of CASTME, Dr. Maurice Goldsmith, was represented by Vice-President, Dennis Chisman, who read a message from the President.

Plenary sessions were given by Kabir Shaikh, Vice-President of CASTME, on the theme Value for Money in Science, Technology and Mathematics Education; by Prof. P. Makhurane, Vice-Chancellor of the University of Bulawayo on African Science, Technology and Mathematics Education, Quality for all Africans; by Jack Holbrook, Executive Secretary, ICASE on Project 2000+; and by Professor L. P. Makhubu, Vice-Chancellor, University of Swaziland on Recent Issues in Science, Technology and Mathematics Education; A Vision for the 21 Century.

Most of the work of the Conference was carried out in small group discussion sessions which gave rise to a number of proposals for follow-up action in the form of projects to be submitted for further consideration by the Council of CASTME and by Commonwealth Secretariat. There was also an agreement to establish a regional branch of CASTME for the African region. The Chairman of this new branch will be Dr. T. Mokoena, Chemistry Department, University of Botswana.

The conference was closed by the Director of the Botswana Confederation of Commerce, Industry and Manpower. A formative evaluation of the conference was undertaken by Bryan Wilson, Vice-President of CASTME. The report of the meeting is expected to be published later in 1994.

CASTME is a member of ICASE.

CASTME participants hard at work
REPORT FROM THE NORDIC REPRESENTATIVES OF THE INISTE/UNESCO MEETING

April 28-29, 1994
Hosted by the Swedish National Agency for Education-Skolverket
Kungsgatan 53, Stockholm

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Review of Educational Changes. Recent Events in Science and Technology Education

Sweden

The Swedish educational system is going through a process of change.
• There is a move to decentralisation with greater responsibility being transferred to the local authorities.
• A complete school reform for the 6-18 sector is in progress.
• The National Board of Education (approximately 700 personnel) has been closed down and replaced by The National Agency for Education (approximately 200 personnel).
• The tasks of the agency are evaluation, development and supervision.

A particular development task of the agency at the present time is to increase the number of students in science and technology education by 50% during the current five year period.

Finland

Changes in 1994 concern the New National Curricular Guidelines which give:
• A school based curriculum.
• Freedom of choice at all three levels, e.g., at upper secondary level only 45 courses of 75 are compulsory.
• Focus towards quality learning rather than quantity.
• Management by results assessment.
• Flexibility.

Denmark

The new Education Act takes effect for the 1994 school year.
• The subject content is less defined.
• There is a cross-curricular emphasis.
• Goals concern central areas of knowledge.
• Science and technology is introduced as a specific subject in the primary school, i.e., prior to the 7th year.
• Environmental matters are entering the curriculum on an increasing scale.
• Changes have caused frustration among teachers who now have "counted hours" and less say in school affairs.

Iceland

A parliamentary committee has been working for the past 18 months to prepare a plan for educational reform and new Education Acts. The report of the committee and the proposed Act for the Upper Secondary level has been published. This has not yet been discussed in Parliament. The pre 16 proposals are not yet published.

Some of the proposals contained in the report and proposed Upper Secondary Act are:
• An emphasis on increased opportunities in vocational education.
• A pruning of choices in the non-vocational sector.
• A new National Curriculum and Guidelines to be written.
• Lengthening of the school year.
• Reorganisation of length of courses.
• Teachers having a reduced say in school committees.

Science, technology and environmental education at all levels has suffered from cut backs. Ministerial posts for officers with special responsibility for these disciplines have been recently abolished. A committee is working on reorganisation of mathematics education.

Science Teacher Associations are most active at the upper secondary level and shoulder a considerable amount of responsibility.

Discussions are taking place at the University regarding a wider based and more varied degree qualification in the sciences. The Ministry for the
Environment is to issue it’s policy statement concerning environmental education in June.

**INISTE Activities**

Finland and Sweden have been the most active.

Finland recognised that too few students were entering the scientific and technology disciplines. FINISTE established a national network to aid the developments needed to make these disciplines more attractive and efficient. One half million Finnish marks were invested in the FINISTE project but total returns were nearer 15 million marks due to grants from industry and teacher time, etc.

The network concentrated on new teaching methods, and teachers who wished to participate were enabled to do so. This program has been working for 5-6 years and is considered to be a success.

The Swedish activities under INISTE and ASP (Associated Schools Project) have mainly concentrated on the Baltic Sea Project which started in 1989. Regional groups of teachers were established into a network and the project is now very well established with several hundred schools taking part.

Sister projects are commencing, for example The North Sea Project.

Denmark and Iceland have so far not created any specific projects but some Icelandic and Danish schools intend to participate in the North Sea Project.

Nordic INISTE conferences have been held in addition to the above activities. The first was held in 1985, the second in Finland in 1989, and the most recent in 1991 was hosted by Norway. The proposed 1995 conference is to be hosted by Sweden.

**The Future of INISTE and the Nordic INISTE Group**

The original initiatives behind INISTE were from UNESCO headquarters in Paris. In recent months the drive and enthusiasm from UNESCO have waned to such an extent that the Nordic representatives were uncertain of the network’s future.

All delegates felt that there is much to be gained by the Nordic countries continuing to communicate in this type of network. No one was aware of any other existing Nordic network between education departments that is specifically related to science and technology education.

**The Fourth Nordic INISTE Conference**

Sweden has taken on the responsibility of hosting the proposed 1995 conference. The proposed time is late April or early May. Changes in the form of the meeting were discussed.

**Conclusions and Recommendations**

**General**

1. The Nordic nations have basically the same educational aims for science and technology education.
2. The methods of approaching the goals seem to be developing differently in the different countries. Developments seem to be at different stages.
3. There is a definite need for much greater communication and information exchange concerning scientific and technological education policies, curriculae, teaching methods, etc., between the Nordic countries.
4. Representatives intend to continue to work at sustaining and building the Nordic network.

**The Nordic INISTE/UNESCO Network**

1. Clarification of UNESCO’s views regarding the future of INISTE and the Nordic groups role in the network was needed.
2. The position of Norway in group participation is uncertain. Attempts to contact suitable agencies in Norway will be made.
3. During the next six months the group will assess the different possibilities and means of continued cooperation either within or without the existing network.

**Nordic Meeting 1995**

1. It is proposed that the planned conference entitled Science and Technology in Society will take a slightly different form.
2. The proposed form is for a Nordic working seminar to consider the Nordic issues, views, trends and policies concerning Science and Technology in the Nordic-European Society.
3. Three to four delegates would be invited from each of the Nordic nations.
4. Arrangements will depend on answers from UNESCO headquarters.
LATIN AMERICAN ASSOCIATION FOR SCIENCE EDUCATION

Kenneth Tobin, Professor
Science Education, Florida State University

The Latin American science educators have organized themselves into an association and August 17, 1994 was the opening ceremony of the first meeting in Panama City, Panama. The association had its genesis in the annual meeting of NARST in Atlanta. A large contingent of Spanish speaking researchers attended the NARST meeting and, with the assistance of people like Alejandro Gallard, the seeds were sewn for an association and its own meeting in Central America.

More than 200 delegates attended the opening ceremony that was addressed by the inaugural President of the association and the Minister of Education in Panama. For the next three days an exciting program of papers and symposia featured research that remains largely unknown to most of the world. There were participants from about 11 Central and South American countries and keynote plenary speakers from the USA, England, France, and Spain. There is a book of proceedings in Spanish (Memoria) that can be obtained from Deyanira Barnett (419 pages). The main organizers of the conference feature some familiar names—Deyanira Barnett, Maria Rosa Montanari, Alejandro Gallard and Armando Contreras.

Interestingly, the main sponsor for the conference was the Education Ministry in Panama who provided $35,000 and a variety of other sponsors that included the Smithsonian and UNESCO.

REPORT OF THE 1994 DORTMUND SUMMER SYMPOSIUM

Jack Holbrook

The 1994 Dortmund Summer International Symposium on Problem Solving and Misconceptions in Chemistry and Physics, held at the University of Dortmund, Germany and organised by Professor Dr. Hans-Jurgen Schmidt.

This 3 day meeting, sponsored by the University of Dortmund in cooperation with ICASE represented the 12th Dortmund summer symposium and was held 25-27th May 1994. The programme allowed 40 minutes for each speaker to present their paper followed by a further 40 minutes for discussion, a well tried approach that again proved highly successful, although users of English as a second language found it difficult to fit their presentation into the allotted time. Presenters came from a number of European countries notably the UK, Belgium, Netherlands, Germany, Norway, Portugal and Greece.

Professor John Gilbert from the University of Reading, UK began the symposium with an overview of research being undertaken in science education in some European countries. He gathered information by means of a questionnaire and sought patterns within the data across these countries. His presentation considered the data within the context of attempts to create a closer relationship in science education research within the European Union.

Alan Griffiths, a speaker from Newfoundland, Canada gave an analysis of research undertaken on students' chemistry misconceptions. He extensively reviewed the literature, identified the main areas where misconceptions were found and listed the specific misconceptions. The paper gave the nine main areas as—Equilibrium Systems, Acids and Bases, Physical and Chemical Change, Combustion, Electrochemistry, Matter, Bonding, Dissolving and Solutions, and Stoichiometry.

Bob Fairborther, King's College, London, UK analyzed information on problem solving and learning by students. His first part of the paper reveals that students do not know how to revise and more generally do not know how to take control of their own learning. The second part of his paper illustrates that students can learn to make decisions for themselves but it entails making clear to them the criteria by which they are being judged. The major conclusion is that teachers spend too much time teaching the subject matter and not enough teaching students how to learn.

Philip Adey, King's College London, UK expounded on the strategy to help students with chemical problem solving capability. He suggested that efforts should be geared to improving general
information-processing capability. The paper reviews what is known about approaches to the development of general thinking, explores the evidence for the success of different methods and discusses the applicability to chemical problem solving.

Vivi Ringnes, University of Oslo, Norway, examined students’ understanding of chemistry and their learning difficulties related to chemistry concepts, exploring the textbook, curricula, written examinations, teaching and the students themselves. Student understanding of the areas of nomenclature, chemical elements, chemical bonding, redox and electrolysis, acids stoichiometry and equations were examined from written answers to multiple choice and open-ended questions.

Reinders Duit, University of Kiel, Germany examined, within a constructivist framework, the learners preinstructional ideas of chaos-theory and discussed the research approach and the preliminary findings.

Christoph Von Rhoneck, Pedagogische Hochschule Ludwigsburg, Germany investigated the interactions between achievement in physics, psychological background and social interactions by means of a questionnaire. Students were divided into continuous and sporadic learners and the differences between these two subgroups were analysed.

Dieter Nachtigall, University of Dortmund, Germany lamented the poor teaching approaches adopted by teachers in many physics classes and explored teaching strategies that motivate students and encouraged them to learn.

Marie-Jose Janssens, University of Leuven, Belgium details her Ph.D. study on the analysis of teacher-made test items in chemistry. Among the findings was that only 10% questions set by teachers demanded a higher intellectual skill and that large discrepancies occurred between schools and between teachers in the same school.

Kerstin Prokoph, University of Halle, Germany presented the initial instigatory approaches to looking at the possibilities of including natural development processes in chemistry lessons and to analyse the level of treatment of the topic that is suitable.

Georgios Tsapartis, University of Ioannina, Greece examined mechanisms that block problem solving from Pascual-Leone’s M-space perspective. Using this perspective a mental capacity (M-Capacity or M-space) is attributed to each subject and an M-demand is postulated for each problem. One block is the lack, in the subject’s repertoire, of any single step in the solving process. A second block is the non-equivalence of the part steps that make up the solution process. Two further hindrances are the presence of noise in the problem statement and the logical structure of the problem.

Iris Pigeot, University Mainz, Germany described the graphical chain model which allows for variables to be regarded, in statistical analysis, simultaneously as responses and as explanatory variables, where some of the variables may be quantitative and others qualitative. In the paper examples are given to illustrate the process. This approach is seen as a powerful alternative to path analysis.

Jeannine Acampo, Utrecht University, the Netherlands, described her Ph.D. study on chemistry teachers’ learning processes: a study of teacher training and reflection on classroom activities. The presentation concentrated on teachers’ problems related to the teaching of electrochemistry. Data was collected from in-service training programmes and from classroom observations. The report gives results concerning changes in conception and strategies of chemistry teachers.

Gabriela Jonas, University of Hamburg, Germany presented a pilot study on physics teachers’ and student teachers’ thinking about laboratory work in physics classes. A comparison was undertaken between the thoughts of experienced physics teachers and student teachers regarding experiments in physics classes through the use of questionnaires, interviews and classroom observation. The outcomes can be used to help clarify why experiments in physics classes often don’t have the expected success for students’ learning.

Mary Atwater, University of Georgia, USA discussed bridging chemical problem solving and misconceptions in different contexts. The paper focussed on problems solving strategies of African-American students in two different settings, problem solving strategies of university students enrolled in two different kinds of laboratory settings and misconceptions of high school and college students in different types of bondings.

Geeske van Hoeve, University of Utrecht, Netherlands described her Ph.D. research into a new approach to teaching chemical bonds. A new chapter on chemical bonding was written after critical
analysis of textbooks. The educational structure had two main characteristics. First a chemical context is chosen as a starting point and secondly, the emphasis is on the making of knowledge as a human activity. In the unit a story is told.

The discussions were extensive and detailed. Generally there was an appreciation that a theoretical model was important for research studies, even if the research was qualitative in nature. It was also recognised that potentially there is much to be gained by pan-European cooperation in research and the opportunity to present and discuss research findings in such a setting. Ph.D. students, in particular, had much to gain from such symposia.

Once again Hans-Jurgen Schmidt is to be congratulated on organising a well run and interesting symposium. It was very gratifying to learn that he proposes to run a further symposium in two years’ time.

Proceedings of the symposium will be printed later in the year and copies can be bought from the ICASE secretariat at US$12 (including airmail).

Conference organizer, Hans-Jurgen Schmidt (far right), joins participants for a little sight seeing.

Ed van den Berg, far left, appears to be mentally formulating thoughts for his article later in this issue.
SCIENTIFIC AND TECHNOLOGICAL LITERACY FOR ALL—THE ROLE OF EDUCATORS

Jack Holbrook
Executive Secretary,
International Council of Associations for Science Education
(ICASE)

Abstract

Last July over 400 participants met at UNESCO headquarters, Paris, to discuss how, in future, scientific and technological literacy can be achieved for all. The forum was called to mobilize support for enhancing scientific and technological literacy for all worldwide and to launch Project 2000+, an internationally conceived drive to improve scientific and technological literacy worldwide through a range of nationally devised projects. The immediate outcomes from the forum were three-fold:
(a) a declaration for Governments
(b) a report summarizing the forum discussions and suggestions
(c) a call for task forces to be created in countries around the world and for the science education community to be mobilized to encourage greater use of research in the classrooms, better curricula that cater for all students and more emphasis on the non-formal sector to enhance the popularisation of science.

Project 2000+ is thus now in need of translation into projects at the national level. Concerns need to be identified nationally, project ideas defined and priorities for projects specified on a national scale. Within the formal sector crucial factors are teacher education and linked with this, the role played by teachers, areas where professional science teacher associations are expected to play a major role.

This paper sets out the rationale for greater attention to scientific and technological literacy and to examine how teachers need to be prepared to guide students towards such literacy, in line with the declaration and forum report mentioned above.

In pointing to the need for better curricula and more appropriate assessment procedures, the paper stresses the importance of placing emphasis on prior teacher education and puts forwards suggestions of how this might be initiated by teachers or teacher organizations, even in the most centralised systems.

Also stressed are the need for teacher acceptance that:
(a) ‘science for the scientist’ is often irrelevant for life within society and that a more social and technological approach to science teaching is needed so that science as a school subject can appeal to students in general and
(b) the heavy overcrowding of science curricula can only be overcome by a radical rethink of the objectives of science education and the emphasis placed on them.

Project 2000+

Project 2000+ is an initiative (ICASE/UNESCO, 1992) that sets out to mobilize worldwide support for action in which governmental and non-governmental bodies collaborate at the country level to achieve a greater level of scientific and technological literacy, perceived necessary for the 21st century. A declaration (UNESCO, 1993a) put forward by participants at an international forum highlights the action needed by Governments and other bodies (appendix 1).

The Rationale for Project 2000+

The World Conference on Education for All (1990) declared that “... every person . . . shall be able to benefit from educational opportunities designed to meet basic learning needs. These needs comprise both essential tools (such as literacy) and the basic learning content (knowledge, skills, values, and attitudes) required by human beings to be able to participate fully to improve the quality of their lives, to make informed decisions and to continue learning.”

It is clear from the above quotation that today’s educational concerns need to be geared to preparing citizens who are empowered to lead productive lives and to enjoy the best possible quality of life. To achieve this, it must be recognized that there is a need to resolve a variety of societal problems which deal with issues such as population, health, nutrition, environment, and sustainable development at local, national and international levels. These societal issues need an increasing degree of scientific and technological literacy on the part of the populace for both understanding and the decision-making involved to stimulate the necessary action. Yet, it would appear that in many countries much basic education in schools includes little that will help students achieve such literacy or feel confident either in
applying their knowledge or in dealing with societal issues and the need for a responsibility for action.

Project 2000+ recognises the growing need for a scientifically and technologically literate society and seeks to:

a) identify ways of promoting the development of scientific and technological literacy for all:

b) create educational programmes (both formal and non-formal) in such a way as to empower all to be able to satisfy their basic needs and be productive in an increasingly technological society;

c) encourage the formation of national task forces [involving personnel from Government, Inter-Governmental Organizations (IGOs), and from Non-Governmental Organizations (NGOs) such as Associations for Science Education] to initiate programmes for greater scientific and technological literacy and to identify and support projects promoting aspects of scientific and technological literacy;

d) support the development of a wide range of projects that aim to improve quality of life and productivity in society and that lead to promoting solidarity and cooperation in achieving scientific and technological literacy for all;

e) provide guidelines for the continuous professional development of science and technology educators and leaders;

f) support the evaluation of existing and projected programmes to ensure scientific and technological literacy goals are being met.

The Target

By the year 2001 there should be in place appropriate structures and activities to foster scientific literacy and technological literacy for all, in all countries.

Scientific and Technological Literacy

As the meaning of achieving scientific and technological literacy is an area of debate, it is appropriate at this stage to put forward the following 17 points, suggested by the National Science Teachers Association of America, as defining a scientifically/technologically literate person (NSTA, 1990-91). The NSTA suggests a scientifically and technologically literate person:

1. uses concepts of science and of technology, as well as an informed reflection of ethical values, in solving everyday problems and making responsible decisions in everyday life, including work and leisure.

2. engages in responsible personal and civic actions after weighing the possible consequences of alternative options.

3. defends decisions and actions using rational argument based on evidence.

4. engages in science and technology for the excitement and the explanations they provide.

5. displays curiosity about and appreciation of the natural and human-made world.

6. applies skepticism, careful methods, logical reasoning, and creativity in investigating the observable universe.

7. values scientific research and technological problem solving.

8. locates, collects, analyses, and evaluates sources of scientific and technological information and uses these sources in solving problems, making decisions, and taking actions.

9. distinguishes between scientific and technological evidence and personal opinion and between reliable and unreliable information.

10. remains open to new evidence and the tentativeness of scientific technological knowledge.

11. recognises that science and technology are human endeavors.

12. weighs the benefits and burdens of scientific and technological development.

13. recognises the strengths and limitations of science and technology for advancing human welfare.

14. analyses interactions among science, technology and society.

15. connects science and technology to other human endeavours e.g. history, mathematics, the arts, and the humanities.

16. considers the political, economic, moral and ethical aspects of science and technology as they relate to personal and global issues.

17. offers explanations of natural phenomena which may be tested for their validity.

The Project 2000+ targets for basic education are:

a) Promoting the teaching of science and technology linked to relevancy in society.

b) Encouraging positive attitudes towards science and technology.

c) Increasing skills in decision making, problem solving communication achieved through science and technology teaching.

d) Development of a greater degree of teaching
resource packages.
e) Reinforcing the use of interactive teaching methods as the mainstay of science and technology education.
f) Development of more relevant curricula in science and technology for scientific and technological literacy for all.
g) Enhancing teacher education programmes.
h) Encouraging a greater involvement of teachers and NGOs in the development, dissemination and evaluation of programmes.
i) Development of more relevant assessment programmes.
j) Implementation of effective evaluation strategies.

The Way Forward

Examining the Issues
Whilst the case for scientific and technological literacy has been stated and an indication of its meaning has been put forward, and whilst much research in science and technology education has given suggestions for curriculum development, popularisation of science and technology and a more enlightened public, the actual direction and method of operation in achieving the goals of Project 2000+ is far from clear.
Issues such as the following are of major importance for education for the 21st century and need to be discussed:

a) the nature of scientific and technological literacy, how to achieve it, what assessment mechanisms are most valid;
b) the degree to which science and technology should be studied for their own sake, or made directly relevant to the concerns and demands of the society and how far basic education in science and technology should establish the groundwork for students wishing to pursue scientific careers;
c) the inter-relation between science education and technology education; and their place as integral parts of the formal school curriculum;
d) the poor representation in some countries of girls in science and technology courses; under representation of women in the practice of science and technology, and in the places where decisions about them are made and, equally important, exclusion from the benefits of science and technology.
e) the popularisation of science and technology

Creating National Task Forces
With the above in mind, the international steering committee overseeing Project 2000+ recommended the setting up of national task forces by Governments. It is envisaged that these task forces would involve partnerships between public and private educational bodies and councils, universities and other institutions of higher and further education, libraries and museums, public and private bodies active in the fields of agriculture, environment, health, industry and commerce as well as organizations and individuals specially concerned with science and technology education.

Suggested Duties of the Task Force
1. To initiate, and to encourage the initiation by others, of national projects (*) in both the formal and non-formal sectors of education (including projects that link both sectors) to enhance STL.
2. To solicit ideas for projects from sources within the country and to undertake needs assessments.
3. To support and liaise with groups initiating STL projects.
4. To prepare proposals for funding by Government, industry, etc within the country as well as for external support.
5. To liaise with the regional centre for Project 2000+, to suggest regional projects and to put forward requests for support and guidance.
6. To advise Government on the priority of projects and on participation in regional cooperative projects.

*The term project here is used to indicate a carefully planned approach and may involve stages (undertaken concurrently or in parallel) that include piloting and feedback, creating resource, training programmes, assessment and evaluation. Projects may be developmental (e.g. curricula related) or research oriented (e.g. needs assessment).

The Role of the Ministry of Education
The local part of Project 2000+ are NATIONAL PROGRAMMES operating at the Governmental, non-Governmental, or both levels. These programmes are planned locally, directly locally, implemented locally and evaluated locally. The role of the Ministry of Education is seen as receiving, and seeking ways to implement, project suggestions from the national task force. At the same time the Ministry of Education is seen as encouraging
non-Governmental developments, particularly by educational institutions and professional teacher associations that initiate national projects by providing data, material and support for national task forces.

National Programmes put forward by task forces could be:

1. adapting, equipping or restructuring existing centres or facilities for supporting the improvement of science and technology education throughout the country, or if necessary creating new ones.

2. providing support for the establishment or reinforcement of professional associations for science and technology teachers which will make important contributions to achieving both the qualitative and the quantitative goals of Project 2000+.

3. providing support for groups or institutions working or willing to engage in the popularisation of science and technology (museums, exhibitions, the media, etc) particularly to help them to focus on people’s needs and to establish good links with the educational system.

4. publicising the need among the general public for greater scientific and technological literacy for all.

5. promoting the status of science and technology education within the community using the formal school sector, the media, and greater community involvement.

6. undertaking a rethink of policy for science and technology education.

7. designing new curricula implementational strategies, resource materials assessment techniques for supporting formal informal and non-formal learning.

8. encouraging more valid assessment instruments to use with students and greater attention to the evaluation of programmes for scientific and technological awareness and literacy.

The Role of Professional Teacher Associations

Major ways in which teacher associations can be involved in promoting Project 2000+, and hence in enhancing scientific and technological literacy, are by:

a) persuading teachers to support the new direction and helping them realise its educational potential;

b) developing materials and other resources to help teachers prepare for a new direction and encouraging teachers to trial them in their classrooms;

c) providing in-service support for teachers through seminars and workshops to introduce plan trials and evaluate strategies and materials related to the new direction;

d) providing resources which teachers may find useful for updating;

e) lobbying the Ministry of Education to take joint action to encourage the ideas and allaying the concerns of teachers;

f) playing a leading role as a member of a national task force in initiating and implementing projects.

An important approach in persuading teachers is through the development of teaching materials that are attractively easy to use and highly motivational. These materials can be directly related to the syllabus e.g. reorientation of the teaching approach that has as its goal:

(i) greater relevance to everyday life

(ii) greater educational value in meeting skills

(iii) greater student involvement

(iv) more logical and interestingly looked at from the students point of view or, encouraging the professionalism of teachers, the materials can be made available for teachers from which teachers select what they consider appropriate.

Besides the above goals, these materials can also:

(v) carry new scientific information

(vi) be a source of information for teachers from which they then develop their own materials

(vii) be interdisciplinary

The Role of Research Institutions (and Professional/Teacher Associations)

If national task forces are to seriously consider the work before them, it is important that they can receive support from research and be able to gather ideas and opinions.

Research is needed in areas such as:

1. curricula needed to achieve scientific and technological literacy and what assessment mechanisms are most valid.

2. the degree to which science education should be directly relevant to the concerns and demands of the society and how far it should establish groundwork for further learning for students wishing to pursue a scientific career.

3. the extent to which technology education

Science Education International, Vol. 5, No. 3 September 1994
should be an integral part of the formal school curriculum and taught separately from science? Whilst these two subjects areas have unique components, there are also areas of great overlap and literacy issues between these subject areas, in which science tends to take on a societal slant, are often heavily interrelated. For developing countries, hard pressed to provide specialised facilities (such as that demanded by pure science), the attractiveness of a technology—science mix for all, may not only be desirable, but could prove doubly attractive when consideration is given to the less expensive, more flexible, facilities that would be required.

4. appreciating, managing and having a sense of responsibility for the environment. This leads to education for sustainable development and how it can be achieved, given that the world is united in concerns such as global change, ozone layer depletion, the fitness of energy reserves and the impact of deforestation.

5. traditionally science education attracted boys, either by offering choice at an age when boys are more easily motivated toward science, or by orienting the science topics for study so that girls have studied science and technology, the research shows that they achieve equally as well as boys. Equity in science and technology education means recognising the importance of science and technology education for all citizens and then seeking to provide a wide range of experiences so that its appeal is appreciated by all.

References
UNESCO. (1993a, July). Declaration by participants at an International Forum on Scientific and Technological Literacy for All. Paris: UNESCO.

Paris: UNESCO.

Appendix

Project 2000+ Forum Declaration

We, participants in the Project 2000+ Forum, meeting at UNESCO, Paris, France, from 5 to 10 July, 1993:
1. Recalling the World Declaration on Education for All, in particular its recognition that sound basic education is fundamental to the strengthening of higher levels of education and of scientific and technological literacy and capacity and thus to self-reliant development and, further recalling recent worldwide expressions of concern for the environment and for the quality of human life, especially those contained in Agenda 21, the output of the United Nations Conference on Environment and Development, Rio de Janeiro, 3-14 June 1992;
2. Believing that scientific literacy and technological literacy are essential for achieving responsible and sustainable development;
3. Declare our full commitment to the promotion of science and technology education for all in keeping with the World Declaration on Education for All, and our readiness to contribute through Project 2000+ to the concerted action set out in the Framework for Action to Meet Basic Learning Needs;
4. Call on governments, industry, public and private sector interests, and education and other authorities in all countries to:
   a) review critically existing provisions for science and technology education at all levels and in all settings with the aim of giving appropriate attention to development and maintenance of learning programmes responsive to the needs of individuals and communities;
   b) assign priority to the development and introduction of programmes leading to scientific literacy and technological literacy for all with the aim of achieving responsible and sustainable development;
   c) take such steps as may be necessary to ensure equity of access for everybody to science and technology education, notably for women and girls, young children and other under-represented groups;
   d) develop appropriate in-school and out-of-school opportunities programmes,
5. Urge United Nations Agencies and other inter-governmental organizations to work together to initiate and support programmes which will advance the ability of countries and of populations to shape their own future in a scientific and technological society and which will increase the capacity of countries for designing, planning and implementing scientific literacy and technological literacy programmes;

6. Urge non-governmental organizations active in fields of science and technology education, as well as the social sciences, and professional associations of teachers and educators and educational organizations at all levels to:

a) enter into partnership with, and make their knowledge and experience available to, United Nations and other inter-governmental bodies as well as establish innovative programmes in a common effort to achieve the goal of scientific literacy and technological literacy for all; and

b) participate in national, regional and international programmes for the enhancement of scientific literacy and technological literacy for the improvement of the quality of life in all societies and for the achievement of sustainable development;

7. Recommend that UNESCO makes provision, within its Medium Term Plan (1996-2001) in the field of education, and in the context of Project 2000+, for an international programme to develop co-operation among all countries in the field of science and technology education, with particular reference to the promotion of scientific literacy and technological literacy for all:

This programme, conducted in partnership with the relevant and competent governmental and non-governmental organizations and agencies, should focus on regional and subregional co-operation and on strengthening networks for exchange of ideas, information, human and material resources for science and technology education, and actively seek to promote world-wide:

a) understanding of the nature of, and the need for, scientific literacy and technological literacy in relation to local culture and values and to the social and economic needs and aspirations of each country and its peoples, and also in accord both with the general aims of education for the all-round development of human personality and with human rights and basic freedoms;

b) identification of those issues concerning the applications of science and technology which are of special importance for personal, local and national development and their embodiment in educational programmes;

c) establishment of teaching and learning environments as well as supporting structures conducive to the achievement of scientific literacy and technological literacy for all;

d) formulation of guidelines for the preparation and continuous professional development of science and technology educators and leadership coupled with assistance to countries in giving effect to them;
c) development of effective communication, both verbal and visual, assessment strategies and evaluation programmes designed to enhance general levels of scientific literacy and technological literacy;

f) support for the non-formal and informal sector in its own right and support for development strategies which will help to stimulate and maintain lifelong scientific literacy and technological literacy;

8. Recommend that by the year 2001 there should be in place appropriate structures and activities to foster scientific literacy and technological literacy for all, in all countries.

SCHOOL OF EDUCATION, UNIVERSITY OF LEEDS
EDUCATION FOR CAPABILITY RESEARCH GROUP

The Education for Capability Research Group was established in 1989 within the School of Education at the University of Leeds. It aims to foster and disseminate research concerned with any aspect of education for capability and its membership reflects a wide range of academic and professional interests and expertise. Further information about the activities of the Group may be obtained from A. Anning, School of Education, University of Leeds, Leeds LS2 9JT, U.K.

The following Occasional Publications of the Groups are available.

Yeomans, D., & Williams, R. (1993). Then and now: Technology in ten of the original TVEI pilot schools. (£1.50).

All prices include postage and packing. Orders should be addressed to the Secretary, Centre for Studies in Science and Mathematics Education, University of Leeds, Leeds LS2 9JT, U.K. Cheques/P.O. should be made payable to The University of Leeds'.

Chameleon Condos, Critters and Critical Thinking

Author: Craig A. Berg
ISBN: 0-9640844-2-4
Publication Date: 1994
Price: $9.95

Suggested Audience: K-12 Science Teachers, Elementary Teachers

This book will show you how to build and use condos; 5-18 bottle habitats that teachers and students make from 2-liter recycled plastic soda bottles. Condos are designed to provide classrooms with low-cost, highly visible habitats that house anoles, cricket farms, ant colonies and provide more close encounters with living things that catch and eat other critters, undergo metamorphosis, change color, lay eggs, hide, and build homes. In addition, the author demonstrates via flowcharts, examples and students blackline masters how to use condos and children’s questions to initiate an interdisciplinary creative problem solving model. Fifty-six pages of activity-based life science for elementary and secondary classrooms to help turn kids on to science.

Published by:

Chameleon Publishing
PO Box 71225
2301 E. Stratford Ct.
Shorewood, WI 53211
(414) 963-4202
Pakistan is one of the South Asian countries entering into strong industrial and productive infrastructure by the end of this century. New and powerful educational forces around the world are giving signal to our nation to develop necessary reforms in education on a permanent basis rather than adhocism before entering into the 21st century. No doubt this is time of science and technology. A decade from now our science education programs will have great impact on the national development. We need to think now. Can our science education programs fulfill the national objective as productive citizen? Does our science curricula reflect a 21st century vision of Pakistani society? Did we design the instructions for the children who, born in 1993, will receive their elementary and secondary science education in the 21st century? Are our schools equipped to meet the requirement of a child of science in the coming century? What research evidence is needed to ensure that we are going to set directions to achieve our national objectives? In this paper some guidelines have been suggested for developing the science education programs for the 21st century in Pakistan and at the end, a proposed practice model has been included.

The twentieth century has witnessed an upheaval of societies resulting in fundamental changes in the political, economic, cultural and intellectual through systems both in the developed and developing countries of the world. This indeed has been the century of accelerated social change which has immensely influenced our concept of education and led to radical reconstruction of educational theories and practices. This is precisely opposite to the intellectual orientation of the 19th century. Perhaps the most spectacular development in all societies has been the application of science and technology in our daily life. The 21st century is the century of exploration of personal and professional growth. The science education must provide an environment where personal and professional growth flourishes.

The enrichment of science and technology education through primary, secondary, technical and higher education is essential to produce the manpower which is required to man the specialized positions in both the public and the private sectors. The supply of manpower through educational institutions must correspond in quantity and quality to the jobs being offered by the national economy. This requires very systematic manpower planning for the 21st century because production of one additional Ph.D (foreign) in specialized subject like physics may cost the nation around a 2.5 million rupee, while the production of one MBBS doctor or an engineer (local) may cost around 600,000/- rupees. If each one of them is not absorbed in the national economy, one may imagine the colossal loss which a developing country like ours will have to bear because of unplanned supply of science graduates in various fields of specialization.

On the qualitative dimension, we need to adopt a prognostic outlook as the students who are opting for science subjects today will play their active role in national economy in the 21st century. The educational planners engaged in developing science education programs must foresee the complexity of scientific and technological operations in the future to develop a viable curriculum for primary, secondary, technical and higher educational institutions.

Our attitude towards science curriculum has been generally conservative. Science curricula reforms now seem to be the concern of every pressure group of our society ranging from politicians to the clerical staff and labor. Besides the present-day context, a science curricula reform undertaking has to take full cognizance of the factors that may emerge as a reality after a decade or two when the children of today participate in the actual life activities of “their time”
i.e. somewhere in the 21st century. So the science curricula reform for that period is to keep a working balance between the triangular forces which bind it.

- Preparation of established content inherited from the past;
- Relevance to the present day needs of both the individual and the society, and
- Projection and incorporation of future requirement of the individual and the society to enable the individuals to respond to "their times."

The science curriculum and the instructional practices of the 21st century institutions must reflect the following principle:

- Student's interest and curiosity increases with provision of individual's involvement in relevant learning experiences.
- Learning science is by doing and students can relate their knowledge to new situation.
- Ample opportunities for students to ask questions.
- Science as process rather than product.
- Every student earns according to his capability.
- Encouragement from society is essential towards the students' progress.
- Use of educational technology and local resources plays important role in learning.
- Emphasis on information related to the environment and society.
- Emphasis on raising awareness of the ways in which science and technology interact with individuals, society, agriculture, industry and the environment.
- Science as way of thinking and dealing with problems.
- Think globally, act locally.

With the massive increase of knowledge of science our schools are no more in a position to handle the situation with conventional teaching methodology. Obviously the school timings cannot be increased indefinitely while there is no end to the process of knowledge explosion which has started in the 20th century. The only possible way to face the challenge of 21st century in the country like Pakistan is by adopting a new approach towards science teaching methodology, production of textbooks and educational technology. The crux of the problem is to ensure effective assimilation of maximum content of knowledge by our students in the shortest possible time. The following guidelines may help our science educationist in planning the strategies and tactics of teaching science in our schools in 21st century.

- Select the fundamental science content.
- Design the instruction for all kinds of students (good, average, weak, male, female, urban, rural public and private).
- Include the content to ask questions frequently.
- Provide opportunities for exploring the scientific concepts.
- Include interested and tested activities from the local situation.
- Sequence the content keeping in view the student's psychology.
- Suggest the methods of teaching science which involve the student's participation and rapid absorption of scientific informations such as inquiry discovery and mind capture etc.

Perhaps the most critical factor which will influence the entire process of science education in Pakistan is the examination system. Most efforts to improve science curricula, textbooks and teaching methods can be stumbled because of the perpetuation of a system of examination which has been least able in past to reform and innovation. The system of examination in Pakistan is beset with various critical issues which continue to remain unresolved in spite of volumes of literature written by national and international experts and organizations since the creation of Pakistan in 1947. The present system of examinations is based on summative evaluation. There is no continuous assessment of students' performance. The final examination is the yardstick for all type of subjects and levels. While planning for the 21st century, we need to think about the following:

- Does the evaluation of science subjects cover the functions for which these are going to design?
- What weightage is to be given to continuum(internal) and final assessment?
- When, where and how the evaluation is to be done?
- Are the fair?
- Do science courses have different grades, norms and criteria?

Table I gives the detailed picture of existing practices in science education in Pakistan and suggests corresponding practices for the 21st century in order to develop science education programs in Pakistan and for the countries of the same.

References

Table I

<table>
<thead>
<tr>
<th>COMPONENT</th>
<th>PRESENT PRACTICES</th>
<th>PROPOSED PRACTICES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objectives</td>
<td>Bloom’s Taxonomy</td>
<td>Performance</td>
</tr>
<tr>
<td>Philosophy</td>
<td>Product</td>
<td>Process</td>
</tr>
<tr>
<td>Planning</td>
<td>Partial</td>
<td>Comprehensive</td>
</tr>
<tr>
<td>Organization</td>
<td>Centralized</td>
<td>Regional</td>
</tr>
<tr>
<td>Curriculum</td>
<td>Written (fixed)</td>
<td>Adjustable (variable)</td>
</tr>
<tr>
<td>Texts</td>
<td>Printed</td>
<td>Guided</td>
</tr>
<tr>
<td>Methods</td>
<td>Controlled</td>
<td>Fluid/varied</td>
</tr>
<tr>
<td>Learning through</td>
<td>Memorization</td>
<td>Experience</td>
</tr>
<tr>
<td>Involvement</td>
<td>Passive</td>
<td>Active</td>
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<tr>
<td>Questioning</td>
<td>Limited</td>
<td>Frequent</td>
</tr>
<tr>
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<td>Laboratory</td>
<td>Field/environment</td>
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<tr>
<td>Resources</td>
<td>Supplied</td>
<td>Local</td>
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<td>Materials</td>
<td>Regional</td>
<td>Indigenous/improvised</td>
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<td>Action</td>
<td>National/global</td>
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<td>Structured</td>
<td>Local</td>
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<td>Institution</td>
<td>Individual/group</td>
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<tr>
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<td>Competition</td>
<td>Cooperation/individual</td>
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<td>World/life</td>
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<td>Individual</td>
<td>National</td>
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ICASE
The First 20 Years
1973-1993

A brief history

This new publication is a brief history of the International Council of Associations for Science Education.

It is not intended to be a comprehensive account, but rather an overview of the key happenings and milestones in the development of the organisation and the policies and strategies that have enabled it to reach its present position in the international community of science education.

It also looks forward to the future, especially to the turn of the century, and examines possible options for the continual development of ICASE as an umbrella organisation for science education associations and similar bodies.

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SCIENCE EDUCATION IN NEW ZEALAND
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Introduction
New Zealand is a country founded by two cultural groups, Europeans and Maori. In recent years there has been an influx of people of many different nationalities, particularly Pacific Islanders. However, the educational system is founded on the British system complete with school uniforms and formal examinations at the end of forms five and seven. When the National party was returned to power, the new Minister of Education requested a redevelopment of the science curriculum for year 1 to year 13.

School Science
In the primary school which caters for children aged 5 to 11 there has in the past often been very little science instruction. Primary teachers usually have little or no formal science instruction themselves beyond high school. From the ages of 12 to 13 (two years) students attend intermediate school where science is taught by non-specialist teachers with varying amounts of training in science. From the ages of 13 to 17 students attend high school and receive science instruction by specialist science teachers who have bachelor’s degrees and often diplomas or masters degrees as well. In forms three to five (ages 13 to 15) students usually take general science. In some schools physics, chemistry and biology can be taken as separate subjects but there is rarely insufficient time on the timetable for more than two of these. At the end of form five the students may sit an external, school certificate examination in general science, biology, chemistry, physics or human biology. In the sixth and seventh forms students take more electives and less compulsory subjects although English is still required. Those who are science bound take three sciences together with mathematics, English and one other subject.

Assessment takes place internally for the award of sixth form certificate. However students are awarded these certificates based on a complex formula for moderation between schools. On the basis of the marks obtained by the students of particular school in the fifth form school certificate examination, the school is allowed to award a proportional number of certificates at various levels from one to six. At the end of form seven students can sit for a bursary examination. Admission to university depends on attaining a minimum grade in these examinations with various faculties setting their own minimum requirements depending on the demand and places available in various programs.

Factors Influencing the Need for Reform
In the education system prior to the reforms of the 1990’s a number of problems in science education had been identified.

1. The internationally recognized work of Roger Osborne from the University of Waikato on children’s learning in science classes (the Learning in Science Project) was widely disseminated. This work supported the growing misconceptions literature and gave further evidence of the need to ascertain children’s intuitive ideas before and during instruction.

2. As a result of the increase in unemployment, many more students were beginning to stay in school beyond the age of compulsory schooling. For many of these students the current science courses were inappropriate. The cognitive demands were often too high, students needed more motivating and encouraging, and many social issues raised as result of advances in science and technology were seldom addressed.

3. The school certificate examination in general science, say by most pupils at the end of form five, had been virtually unchanged for 20 years. The examination, for the most part, assessed knowledge of factual information. Students had the option, in some schools, of taking each of the three traditional sciences separately, but generally the pressures of time for other subjects precluded this. It was quite possible to do well on the examination without ever having completed any laboratory work. The examination tended to reward rote learning at the expense of genuine understanding and encouraged expository teaching.

4. Pressure from government and industry to produce scientifically literate high school graduates was increasing as it was for all students to take science at least to form five.

5. Pressure from Maori leaders to take account of Maori views of science and their science knowledge was mounting.

6. A considerable increase in the diversity of students’ cultural backgrounds, achievement levels and motivation, demanded new approaches to classroom practice.

7. For science education to begin in the primary schools, considerable teacher re-education was necessary for practicing teachers to upgrade their skills.
A New Science Curriculum
Under the strong influence of the findings of the Learning in Science Project and the constructivist viewpoint, a draft curriculum for science from entry to form five was produced in a short time by a team of 13 writers. One of these was from a university, three from colleges of education and the rest school teachers. That input from the universities was so meager, was a direct result of the perception that the university science faculties had dominated the high school curriculum for too long and were interested only in perpetuating a science methodology and content aimed at the pre-university student. An advisory group of 12 people commented on various stages of the drafts. However, these comments seem to have only been heeded when they supported the general philosophy that the writers espoused. Any dissension was apparently dismissed.

Within each of the six strands of the curriculum statement are eight levels with each level specifying four achievement objectives. These objectives are very broad and emphasize investigative skills. It is suggested that the learning should be contextual and sample contexts are given together with possible learning experiences. An instructional plan, consistent with these general objectives is devised by each school to respond to the needs of the students in that particular school. The whole document is a radical change from the prescriptive statements of the past. The draft statement was circulated to many interest groups to solicit reactions. Many school teachers applauded it, many scientists were appalled at the lack of conceptual framework, the missequencing of objectives and the unsuitability of objectives for various levels. As combination of post-modernism and constructivism lead to the notion that the understanding that the child builds for herself about the world as a result of observation and social interaction is as valid as any other understanding of the world including that of scientists, came in for a great deal of criticism. This prompted articles in the popular press, public meetings and seminars and which divided the educational community. Nevertheless the draft was approved and became the official curriculum with only minor changes.

The teaching methodology demands a more investigative approach than is current practice, requiring that teachers receive in-service training to upgrade their skills. This has been implemented through programs in which a facilitator (a teacher co-opted to the Advisory Service) works with a group of teachers in a cluster of schools over an extended period to support the teachers individually in their attempts to modify their teaching. It remains to be seen whether these interventions have any lasting effect.

Implementing the New Curriculum
Only very broad guidelines as what should be taught at each level are provided in the statement. This means that each school must develop its own instructional plans. A suggested contextual methodology may be recognized as relevant to students interests but encourages a fragmented accumulation of science knowledge rather than establishing the coherent framework of the conventional approach. While the larger, urban schools have several, experienced teachers in each science area who can work together to produce a coherent overall plan, this may be more problematic in the small school and with less experienced teaching staff. There is a need for greater formal lines of communication between teachers to share resource development. With the lack of prescription and consequent lack of uniformity in subject matter, there are few suitable texts. This means that teachers have the task of collating their own reading material and resources for each of their classes. While this enables teachers to adapt their teaching to local conditions and resources, it also puts an extra strain on teachers' preparation time. Instead of implementing the new curriculum on a one-year-at-a-time basis, the whole is being implemented simultaneously. This means that the instructional materials that may be suitable to say a fifth form class that is new to the investigative approach may not be suitable for a fifth form class that has been initiated into this form of learning in form three. This puts an extra burden of preparation on the teacher.

Summary
This paper has attempted to outline the developments in science education in New Zealand in response to research evidence and the requirements for universal science learning. A fundamental change in the philosophy and methodology of science teaching may produce a more scientifically literate citizenry. It remains to be seen if the lack of a coherent knowledge framework is disadvantageous to students who wish to pursue science at the tertiary level, and whether or not a constructivist approach does result in better fundamental understanding of science for the average student.

Science Education International, Vol. 5, No. 3 September 1994
SOME ISSUES AND PROBLEMS RELATED TO SCIENCE TEACHER EDUCATION PROGRAMS IN KOREA

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Introduction
The highly scientific-technological nature of Korean society requires quality science education in schools. Efforts have been undertaken to assure that science teacher education programs provide quality instruction in educating new science teachers in response to this need for better science education. Training effective science teachers is one of the most important steps for the improvement of science education. In Korea, science teacher education programs are designed to carry out the major role of training science teachers according to the Korean educational law.

However, research indicates that most teacher education institutions do not have an effective science teacher education program even though the Korean public continues to call for greater accountability from teacher educators, better quality of science instruction in schools, higher standards of the qualification of teachers and increased teacher competencies in order to improve science education in schools. If a science teacher education program is to meet these demands, as well as to maintain and improve the curriculum, specific attention must be paid to the professional needs and problems of science teacher education programs.

Science Teacher Education Programs in Korea
Three major programs in Korea educate middle and secondary school science teachers: (a) programs offered by teacher education institutions with the completion of bachelor degrees; (b) programs offered by non-teacher education institutions with professional education courses for the completion of bachelor degrees; and (c) program offered by graduate schools of education for the completion of a masters degree. In order to qualify as a middle or secondary science teacher, teacher trainees must complete more than 140 credit hours in the areas of general education (university studies), professional education, and a specialization in science as a field of study. In addition to these requirements, since 1991 teacher trainees must take an examination, administrated by the Ministry of Education, in order to be employed by schools. The examination is designed to improve the quality of teaching.

Issues Related to the Certification Processes
Lack of an exam to certify teachers' subject area competency led to many problems. The certification process with no examination allows anyone who completes the required credit hours in a teacher education institution to be a middle and secondary school science teacher. Park and Lim (1986) noted that teacher education programs did not have any system to differentiate the quality of certified middle and secondary school teachers. Kang and Lee (1987) pointed out that teacher education programs created a surplus of teachers by supporting the perception that anyone could be a teacher. In addition, the quality of teachers had become questionable.

In order to select better qualified teachers for schools, the new education law was established in 1991, requiring middle and secondary school teachers to take an examination to be employed. Lee (1991) summarized the functions of the new system of administrating an examination to certify teachers upon the completion of teacher education programs. First, the administration of an examination would ensure the quality of graduates of teacher education programs with no examination. Second, the procedure and content of the examination would influence the management and organization of the curriculum of teacher education programs. Third, the people's perception of teachers would be improve in terms of trust and respect.

However, the examination has often led preservice teachers to study and memorize rote knowledge in preparation for the examination. Park (1992) reported that some senior students in teacher education programs avoided attending classes, choosing to spend their time memorizing for the exam. Some teacher education institutions reduced the number of laboratory courses and offered a new course designed to prepare students for the examination. The new certification process with the examination raises problems in relation to the fundamental procedure and purpose of selecting better qualified teachers due to the fact that the organization and management of the examination were not carefully considered.

Issues Related to Curricular Characteristics
Although the number of required credit hours for graduation is 140, most teacher education institutions require more than 140 credit hours for the completion of the teacher education programs. While students are completing many courses, some feel this does not ensure their competence.
Jung (1991) claimed that there is no close relationship between the content of courses in the fields of study and the content of middle and secondary school science courses. The content of the courses in the fields of study needs to correspond to those of secondary school curriculum. Practicing secondary science teachers strongly expressed that they need to have a curriculum of interdisciplinary science courses (Soo, 1993). Professional education courses also are seen to provide any connection between educational theories and teaching in classroom. Lee (1991a) claimed that the content of these courses was often overlapped, too theory-oriented, and only partially organized, depending on the instructors’ major areas of research and interests. Students, not satisfied with these subjects, consider these courses as a waste of time. They view these courses as superficial credits for teacher certification.

Park (1984) surveyed instructors’ opinions on science teaching methods courses from 59 science education departments. He found that no instructor was satisfied with four credit hours for science teaching method courses and all proposed more credit hours. Seventy-one percent of instructors suggested that 10-14 credit hours were the most reasonable range for the courses. Moreover, instructors noted that problems included a shortage of teaching materials, minimal qualification of instructors, and poor facilities and financial support for research in science teaching methodology.

Kim and Kim (1989) analyzed the content of science teaching methods courses among 18 biology education departments. They found that only 40% of the content of the science teaching method course was related to teaching methods and the remaining 60% was related to learning biological knowledge. Thus, methods courses were, in many ways, content courses rather than methods courses. They concluded that concrete objectives and proper goals for science teaching method courses are badly needed.

For student teaching, Seok (1985) insisted that four-week student teaching was far too short for students to experience and understand teaching in any meaningful way. In addition to the short period of time, Jung (1991) stated that one of the most difficult problems was the insufficient number of middle and secondary schools to accommodate the preservice teachers. Because of this problem, several other difficulties arose in student teaching such as too many students in one middle and secondary school and too few opportunities to experience actual classroom teaching. Further, there was no close relationship between instructors supervising preservice students and practicing teachers supervising preservice teachers. The instructors at teacher education programs supervised preservice students by sending them to middle and secondary schools. On the other hand, practicing teachers at middle and secondary schools tended to be reluctant to let preservice students take over their classes because they took more time in teaching a certain content than practicing teachers did.

Issues Related to Instructional Characteristics
With respect to issues related to the instructional characteristics, the Association of Korean University Education (1988) stated: “The common instructional materials for science teacher education have been chalk, chalkboard, a textbook and the use of the lecture method. Various audio-visual materials, computer systems, books related to science education, development of textbooks, microteaching, development of module of experiments, planetarium, and a specimen room have not have been considered as related to classroom teaching in science teacher education programs. More surprisingly, such conditions of science teacher education programs have been naturally accepted as normal.”

Kwon (1991) found that the courses in science teaching methods in science teacher education programs are based upon theory-centered lecture methods. Science teacher educators usually gave theory-oriented lectures about inquiry teaching methods and other instructional approaches in the science teaching methods course. They teach far differently than they say teachers should. Little time was spent in developing preservice science teachers’ ability to actually practice or experience inquiry teaching methods. He noted that one of the important roles of science teachers in the classrooms is to facilitate students learning scientific knowledge through problem solving skills and scientific methods. The science teacher’s role in the classroom is not to help students to learn how to memorize scientific facts but to learn how to use and understand them. Thus, the course in science teaching methods should employ discussion-centered teaching in order to develop preservice teachers’ ability to practice different instructional approaches including inquiry and problem solving in their science classroom in schools.

Issues Related to Science Teacher Educators
In Korea, there is an extreme shortage of teacher educators who majored in science education and in science teacher education programs in Korea (Kim & Oh, 1991). In the early 1980s, only two of
174 faculty members in Korea had obtained doctoral degrees in the area of science education. Most science teacher educators in science education programs spent little time on research in science education and developing teaching materials. Rather they spent their time on conducting research in the areas of science, not science education. They lack science education background and this affects their ability to teach a science teaching method course and to supervise student teaching as well as their interests in science education as a discipline. Obviously, more professionally educated science educators are needed in Korea.

Conclusion
These issues and problems in teacher education programs in Korea deserve attention from science teacher educators, policy-makers, and administrators. Reform for these problems must be implemented at every level and in a significant fashion. We must see broad perspective in improving science teacher education programs in Korea while creating an agenda for discussions with science educators and related professionals around the world.

References


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NARRATIVE AND SCIENTIFIC LITERACY

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Abstract
Many current science curricula make specific demands on students for the achievement of some level of scientific literacy. The details of what this means, and how it is to be achieved, have often been left for the teacher to elaborate. This paper argues that narrative offers a structure that allows scientific concepts to be (1) more easily integrated into other conceptual understandings, and (2) more easily recalled.

Narrative Defined
What is narrative? Given the enormous literature that has arisen around this word and its place in human language and thought, a more appropriate question might be; what will narrative be taken to mean here? It is tempting to apply the word story as a working definition of narrative. But of course story itself is badly in need of more precision of definition, as well as conveying, perhaps unfortunately, a hint of something immature and unable to deal with the rigorous analytical and descriptive needs of science. Through the work of scholars of language, it has become clear that stories per se do not encompass or define what should be understood by the term narrative.

For our purposes, it is enough to adopt a common sense interpretation, and think of narrative as the telling of sequential events in a way that portrays a meaningful, coherent whole. It implies a teller, referred to from now on as a narrator, and a receiver, or narratee. It is familiar to us in the countless narratives we tell ourselves and others every day; how I lost and found the car keys; who I met at the dentist; how will I organise my next seminar; why did he look at me like that? Narratives are not bound by length, or time of telling, or skill of narrator.

Specific arguments for narrative
In what follows, two specific arguments for the usefulness of narrative in science education are presented. They are based on, firstly, considerations of curriculum integration, and secondly on the value of narrative for structuring curriculum content in the mind.

1. Curriculum Integration
For the purposes of this paper, let us assume that the various science curricula’s content satisfy contemporary demands for student exposure to current cultural concepts as these impinge on, or are influenced by science. It is argued here that these curricula lack a recognised integrating mechanism to bring about the anticipated and valued links between content in various curricula areas outside of science. Not surprisingly, I take the view that narrative, or more simplistically that literary form generally referred to as story, can provide such a mechanism.

In the past, there have been competing attempts to identify a skill, or theme, or process by which to braid into a single cable the separate strands of the curriculum. At one time ‘critical thinking’ was seen as the adhesive force; ‘Language Across the Curriculum’ (Marland, 1977) represented another attempt, one closer in principle to what is argued for here. These approaches rightly tried to find commonalities in the structures of the separate disciplines (i.e., they all are based on conceptual thought embedded in language), or in a skill that is seen to be useful in the analysis and evaluation of them all (i.e., problem solving or critical thinking). If narrative is to fare any better than these past efforts at playing such an integrating role, it must display some clear advantages. One such advantage it has at the outset is that it can, even with no stronger claims being made, prove valuable by contributing to meeting SACE demands for scientific literacy. A full analysis of the nature of scientific literacy is beyond the scope of this paper; suffice it to say that narrative may not only be a stepping stone to student competence with the formal language of science, but may indeed be the preferred mode of scientific language at the student level. Leaving that aside, what can narrative offer in terms of the science curricula?

One powerful argument in favour of narrative, suggesting that it is one of the wired-in, essential

Science Education International, Vol. 5, No. 3 September 1994
representatives of human thought itself, will not be examined here; reference can be made to the work of Hardy (1975) and Kerby (1991). Instead, the weaker claim is made that narrative allows easier transfer of knowledge across disciplines. That is, if the student has placed discipline knowledge, gained through the hard-won (and still contested) methodologies of that discipline, into a narrative structure that is personal and clear (to them as narrators, and clear to the narratees), then the narrative form itself will place that knowledge in such multiple contexts that it is no longer compartmentalised, but integrated. Put another way, the narrative structure can be seen to be similar to a concept map, but one that explicitly links disparate understandings into a coherent whole (that of the narrative) and values those links (because they form and allow narrative to occur). Narrative is thus seen, not as a common element of all discipline knowledge, nor as a skill that should be applied to them all, but as an adhesive force, a binding force, that brings diversity into coherence.

We are bound one to another by the narratives we share (and can share); the more narratives we have in common, the more tightly we are bound to the culture that contains such stories. If we increase the number of narratives we share, we increase our coherence between a wider range of cultural elements. Put in a specific context, to establish curricular coherence with science, students need to share in the stories about matter and energy and life that scientists tell each other. They can do so by reading the narratives directly in the research articles, of course, though this requires a degree of knowledge and experience with science that usually lies at the end of schooling. Or they can encounter such narratives through the work of the popularisers of science. Just as importantly, if not more so, students can also construct their own narratives in which science plays a natural, unforced, necessary role. It is in this second activity, as creators of narratives involving science, that the opportunity exists for them to use narrative to forge the links between disparate knowledge. Science concepts can take their place in the narrative alongside history (discipline or personal history), poetry, human relationships, political thinking, or whatever, simply because the narrative form is infinitely flexible and accommodating.

2. Narrative as a Pedagogic Tool

A second argument for the value of narrative in science education is based on the pedagogic value of narrative. In this view, narrative, by its very structure, places concepts in acceptable, easily assimilable and memorable form. Put simplistically, it suggests that what we encounter couched in narrative form, we remember. This view is argued for on at least two grounds.

First, the narrative format is one of great, if not universal, familiarity to all cultures. If someone from our Western culture states “Once upon a time...” we all know what is to come. We remember such narratives because they are couched in a format with which we are all familiar. The way the narrative is sequenced (from beginning to end) appears to permit if not actually demand easy recall; one event immediately suggests its successor. This sequential structure is familiar in many more artificial mnemonics, or aids to memory, where objects to be remembered are chained in the right sequence into an artificial story; as the story unfolds, the to-be-recalled objects appear on demand.

Second, sequence alone is not enough, of course. The narrative must not be so artificial that memorisation is by rote, as the Koran is chanted by those who speak no Islam. For it to be put in the personal, meaningful form, the narrative must also be couched in the appropriate language of the narrator. For readers of such narratives, it is a question of the selection of narratives written by others which do this most successfully, with the ultimate aim of being able to read narratives as found in the mature discipline. For the writers of such narratives, it is a question of finding ways of becoming more and more competent at the production of narratives that more fully reflect the scientists’ world views as well as maintaining personal connections to the knowledge. In other words, the narrative must be as true to actual science as possible while still being the student’s narrative; it must tell both the true story of matter and energy while fully representing the world of the narrator. If it does both, then it will be more fully present to the mind as an object of contemplation whenever desired.

References


Teaching Materials and Strategies

PRE-SCIENCE EXPERIENCE KIT (PEK)

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Abstract

Multi-sensory kits can be powerful scientific teaching aids. To help lower-primary children learn science concepts, a kit was developed along with a Cassette of rhymes. Five such hands-on activities using readily available materials were initially developed and tested. The activities were fun using toys that employed various science concepts and principles. The toys were made by the children themselves so that they could gain manipulative skills. After the activities, scientific hands-on experiences were reinforced through rhymes for which an audio cassette was prepared as an integral component of the kit. The children enjoyed the program and held favorable opinions about it. The kit is inexpensive, and for five activities the cost per kit is less than 20 cents U.S.

Introduction

There is no doubt that the education of young children should take into account their play tendencies but care must be taken that play activities should not stimulate interest and fun alone, rather the activities should lead to learning. The unstructured play activities must be extended to directed structured activities to induce learning. Furthermore, even new science concepts can be learned from rhymes.

Inexpensive and improvised toys not only provide children fun but give them hands-on experience in simple technology, design problems and aesthetics. The fun in learning provides freedom to the children to express themselves and such freedom is essential in the process of growing up. It was observed during the program that the make-yourself-toys with readily available materials, make children active participants in comprehending the functioning of the toy.

Education should afford young children opportunity for manipulation of materials and improvisations which implies avoiding that which is already ready made. In such a situation only the child’s experience can lead to self expression and encourages creativity. For this, as it was realized during the program that a teacher of young children has to be like a child in spirit and unsophisticated. This kind of mental make up of the teacher can draw out the best in a child.

The PEK program is based on the idea that children can learn science from simple toys made from discarded or inexpensive materials.

PEK encourages:
1. hands-on experience in making the toy (learning by doing).
2. free play with the toys as an unstructured activity.
3. investigation with the toys as structured activity.
4. reinforcement of scientific terms with rhymes.
5. providing each child a personalized inexpensive kit.

The main intention of developing the kit was to use it as a teaching-aid in popularizing science, particularly the basic knowledge of the physical world among children in the age group of 5 to 7 years of age. From a survey of folk toys the following five toys were identified for the trial phase.

<table>
<thead>
<tr>
<th>Toy</th>
<th>Materials</th>
<th>Related Concepts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Go-cart</td>
<td>Empty match box (1), Empty refills (2); Injection bottle rubber caps or buttons (4); needles or stiff wires (2); thread (1m)</td>
<td>Forces; motion; friction</td>
</tr>
<tr>
<td>Jerky-Perky</td>
<td>Empty refill (1); thick thread (1); cloth clip (1)</td>
<td>Types of motion; mechanical energy</td>
</tr>
<tr>
<td>Clapper</td>
<td>Cardboard pieces (4cm x 4cm); Rubber band (1)</td>
<td>Sound; transformation of energy</td>
</tr>
<tr>
<td>Paper pin-wheel</td>
<td>Stiff paper (10cm x 10cm, 1); Pin (1); Empty refill (1); reed or pencil (1)</td>
<td>Kinetic energy; work; non-conventional energy</td>
</tr>
<tr>
<td>Paper pressure-tube</td>
<td>Paper, foolscap (1)</td>
<td>Air exerts pressure; pressure gauge principle</td>
</tr>
</tbody>
</table>
The improvisations were carried out to make it feasible for children to assemble these toys without sacrificing quality.

The PEK was developed to impart basic science concept with the help of the toys which rural and semi-urban children generally make and play with. It has been observed that children play with such toys unconscious of the instructional potential of the toys as far as science principles and concepts are concerned.

**Components of the Kit**

The kit has four components which constitute the complete teaching-aid package as shown in the following table.

<table>
<thead>
<tr>
<th>Component</th>
<th>Brief Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hands-on Kit</td>
<td>This consists of an assorted collection of readily available materials in a shoe box to make five toys to impart hands-on experience on low level physics and technology.</td>
</tr>
<tr>
<td>Do-it-yourself instructional sheets</td>
<td>These activity sheets carry instruction for assembling the toys. These sheets are mainly for the teacher for demonstration of toys.</td>
</tr>
<tr>
<td>Sing-song Booklet</td>
<td>This booklet gives the words of rhymes on each of the five toys of the kit.</td>
</tr>
<tr>
<td>Audio-Tape</td>
<td>The audio cassette consists of the recorded rhymes sung by the students and teachers who were involved in the development and trial of the program.</td>
</tr>
</tbody>
</table>

A sample activity instruction sheet is as follows:

**Go-Cart**

1. Take an empty cigarette box and remove its inside foil.
2. Make two holes in each of the two long sides of the box, near the ends.
3. Pass stiff wires or thin round reeds through the holes to work as rolling axles.
4. Flatten the four crown caps to work as wheels.
5. Make holes in the center of each crown cap using thick nail, nut and hammer.
6. Take four pieces of bicycle valve-tubes nearly 3 to 5 cm. long.
7. From one end of the valve-tubes make it sharp by cutting it obliquely with scissors so that it passes half-way easily through the four crown caps (with holes in the center).
8. Attach the four wheels to the rolling axles neatly by inserting valve-tubes.
9. Tie a thread to the go-cart for pulling it.

**Additional Activities**

**Rhyming and Singing**

After the children have performed the activities and interacted with the teacher, the related science concepts, facts, terms, principles are reinforced through singing of rhymes and songs written by the members. To make the task easier, an audio-tape was produced. Care was taken to fashion the rhymes on the tunes of well-known nursery poems. As singing combines the fun with learning, the children are able to remember the concepts, terms and facts of basic science easily and relate them to the activities already performed by them in making the toys.

Below is a portion of the Go-Cart Rhyme.

**Go-Cart**

Make a go-cart just now,
Pull the go-cart just now,
Push the go-cart just now,
See the wheels roll just now,
See the go-cart move just now,
Remove its wheels just now,
Sliding is hard just now,
Fix the four wheels just now,
Rolling is easy just now

**Trialing**

One 40-minute period per day was given in the regular school time-table to each activity of the Pre-science Experience Kit as per the following schedule:

<table>
<thead>
<tr>
<th>Table II. Weekly Schedule</th>
</tr>
</thead>
<tbody>
<tr>
<td>First day</td>
</tr>
<tr>
<td>Second day</td>
</tr>
</tbody>
</table>
Third day  Structured activities with the students involving investigations and findings out.

Fourth day Discussion and ideas for further activities from the students.

Fifth day Feedback from students and any further improvisations with the toy.

Sixth day Singing of the rhyme based on the preparation and science concepts involved with the toy.

First, the pre-assembled toy was shown to the class and they were asked to identify its components and materials. Very enthusiastically, children started responding and then we went and collected things from the immediate surroundings.

Then with relevant instructions, they made individually the toy and played with it as they liked.

Later on some structured activities were performed with each toy. One example of the structured activities carried out by the children is as follows:

**Go-Cart**

Each child was allowed to run his toy down an inclined plane to find out which one goes farthest? They also measured the distance. This was followed by a discussion to find out the reasons for variation in the distance moved by the Go-carts as they rolled down the inclined plane.

**Children’s comments:**

* I liked my Go-cart because it moves. I can play with it and we can have a race.

* I can decorate it by using nice designs.

**Comments of the Team members:**

* During the development of the toys, I had a big question in my mind, could anything worthwhile be done through such inexpensive and throwaway materials? But while trying in the classroom situation, the overwhelming response of the children and the satisfaction the teacher had in the class, I realized the potential of such an exercise. I felt immensely happy to see the children enjoying and learning simultaneously.

* Holding the script, while working in the kitchen or drawing-room or during a walk made my mind like a tape-recorder playing tunes continuously. Some fitted in popular tunes without effort, though the original words had to be constantly changed to adjust the rhythm.

Next day when I hummed these songs in the class, children raised their eyebrows, gave a surprised grin and joined instantly. Well that worked!

### CALL FOR PAPERS

**NSTA 1996 INTERNATIONAL CONVENTION**

NSTA invites your proposals to present a session at its 1996 International Convention on Science and Science Education, to be held December 27-30, 1996 in San Francisco, USA.

The convention, to be chaired by NSTA Executive Director Bill G. Aldridge, will bring together scientists and K-college science educators from dozens of science and science education societies and organizations worldwide. Invitations have already been sent to societies in more than 30 countries. Holding the event in San Francisco, it is hoped, will especially encourage participation from Pacific Rim countries.

At this convention, participating teachers and science educators will present sessions in their areas of expertise (interdisciplinary approaches are encouraged) to scientists who are not as familiar with the classroom. In turn, scientists will present sessions about their work to nonspecialist scientists and to educators less familiar with the latest news from the research laboratory.

For proposal forms, contact NSTA 1996 International Convention on Science and Science Education, c/o Convention Office, NSTA, 1840 Wilson Blvd., Arlington, VA 22201. If your organization would like to participate, request details and deadlines regarding blocks of sessions.

Completed proposal forms due December 1, 1994.

Meeting space is limited, so proposals sent after the above deadline but before February 1, 1996, will be considered only if space is available.
The classroom: While researchers are debating the merits of all kinds of complicated teaching methods and many of us are discussing the lofty goals of project 2000+, I often visit classrooms (in the Netherlands and abroad) where very elementary things go wrong. For example, many students have not done their homework, teachers know little or nothing about the ideas (alternative conceptions) students bring to class, a whole period may be spent on laboratory work without a clear and articulated purpose, the crucial post-lab discussion on what we learned from the lab experiment rarely takes place (in my experience), pre-lab discussions on “what we want to find out” and brainstorm on “how could we” are rare, lessons are not being evaluated on effectiveness, little distinction is made between main objectives and irrelevant details, and sad but true, sometimes classroom discipline is absent and nothing is learned. Meanwhile the debates of researchers and policy makers continue, on the merits of constructivist teaching, on activity or laboratory based science teaching, on student-centered methods, etc. However, in many cases preconditions for the use of the “haute couture” of teaching methods are not being met.

The examples mentioned above, are rather trivial. It should be trivial that a teacher should evaluate the effectiveness of a lesson and monitor student understanding, yet frequently it does not happen. The many variables involved in teaching (20-40 students with their characteristics, curriculum demands, national exams, school policies and meetings, relationships with colleagues, etc.) easily distract the teacher from main goals and from the good teaching behavior which should be trivial.

Walberg (1991) has conducted nation-wide studies in the USA to find out which elements in teaching correlate with good student achievement. According to him successful teachers practice the following steps:
(b) daily review, homework check, and, if necessary reteaching;
(b) rapid presentation of new content and skills in small steps;
(c) guided student practice with close teacher monitoring;
(d) corrective feedback and instructional reinforcement;
(e) independent practice in seatwork and homework; and
(f) weekly and monthly review.

Other researchers of “effective teaching” have come to similar lists of elements of successful teaching.

Please note the emphasis on 1) student work and 2) teacher monitoring and feedback. So a decent part of the lesson (up to 50% ?) should be used for work by students while the teacher can go around and check on their progress and understanding, and find out whether homework has been done. This self work by students frequently gets replaced by more teacher monologue or it degenerates into student talk about “everything”. What is needed are meaningful (and motivating) tasks and exercises for students to do as work at home or in school and a teacher who is disciplined and has sufficient subject matter mastery and pedagogical skill to monitor student work. And not to forget, in many countries textbooks for students are the major (or even only) resource for doing their assignments. Is all this information new ? No, of course we knew this already. What did we learn then? That before we try to achieve difficult and risky changes in teaching methods used by teachers and curriculum goals (project 2000+), we better look whether the basics (student work and teacher feedback) still need to be improved. Also “modern” teaching methods and certainly constructivist methods will not work without these two elements.
Some interesting hints for student exercises are given in various publications of Nachtigall (1992). He distinguishes nine kinds of exercises for conceptual learning but I will only discuss a few:

1. **Explain in your own words the following terms ...**
   (just fill the new concepts you want to exercise).
   Realise that correcting an exercise like this can demand considerable subject matter mastery of teachers.

2. **Acceptable or not? Explain!** Here one could use statements produced by exercise 1 and have students decide whether they are acceptable for the scientist or not. One could also use statements from misconception tests.

5. **Solve problems** (just the common textbook problems). One could say this is exam training for typical exams. It could be made more meaningful by teaching some general problem solving behavior rather than only physics or chemistry, or math problem solving. For example, one could require students to always make a drawing or diagram of the problem, to **explore** the problem in different ways before starting to solve it. One could get students to make a prediction first of what could be a reasonable outcome. Then they could start solving the problem while at the end they would be asked to look at their result and decide whether it is **reasonable**.

6. **Write a summary of the lecture or chapter.**
   Students should learn to distinguish main points and minor points. Remember that the preparation of a “spiekpapier” (notes for cheating at an exam) was always a very good exercise as long as it was not used during the exam! So let them make it!

Now if student work and teacher monitoring and feedback are working well, and if other trivial elements of effective teaching are also in place, then we can move forward past the basics and get to the exciting stuff. For example, student investigations rather than “cookbook” worksheets, projects, etc.

**In-service teacher education:** In a review of research of in-service teacher education (in the USA) Joyce and Showers (1980) distinguish between “tuning (conventional) teaching skills” and “mastering new teaching strategies”. These conventional teaching skills could include: involving students more, asking more penetrating questions, managing logistics more efficiently, increase the clarity and vividness of presentations and illustrations, etc. The new teaching strategies could include switching to student-centered strategies or to constructivist teaching. The conclusion of Joyce and Showers is that learning new strategies (amongst others) requires considerable in-class coaching of the teacher and that often there is a dip in performance before the benefits of the new methods are realized. On the other hand, “fine tuning” of conventional strategies is a simpler and more evolutionary process with a better chance of success. Many preservice and inservice programs in high-income and low-income countries do not fulfill the condition of availability of expert in-class coaching.

In short, before promoting relatively large changes in teaching strategies, it would be wise to check whether preconditions for success have been fulfilled (coaching by expert teachers). Furthermore, it would be wise to seriously compare various alternatives for investment in improvement of quality. In low ranked schools (bottom 40-50%) in low-income countries provision of textbooks (1 textbook per 5 or 6 students is quite common) and training of teachers in how to use them (!), might pay off more than a complete switch to other teaching methods.

An alternative line of reasoning is that conventional teaching skills are basic tools for any kind of teaching, conventional and otherwise. So skills like explaining, asking questions, guiding discussion, blackboard writing, demonstrating, etc. will have to be trained in any teacher education program whether conventional or not.

Another reason for taking conventional teaching seriously in a teacher education program is that graduates need survival skills for their first years of teaching, to survive between colleagues and pupils. To survive new teachers need to be competent in the basics. The opportunities for innovation will only present themselves when the new teacher has shown competence in the basics. This may be even more true in low-income countries than in (perhaps) less hierarchical high-income countries.

In short (total duration 2 years) teacher education programs in Indonesia our colleagues and I focussed first on common conventional methods and trained students in improved versions of those (table 1). The
improvements we sought and trained were teacher-student interaction (including attention to student conceptions), more use of interactive demonstrations and other ways of making science "visible", frequent linking of school science with every day life examples in the local environment and technology. Furthermore we emphasized meaningful student assignments and exercises and proper teacher feedback. One of the demonstration methods we trained was the Predict-Observe-Explain (POE) demonstration type of White and Gunstone (1992). Many experiments for POE demonstrations were taken from a book with counterintuitive experiments which do not demand any extraordinary equipment (Liem 1987). Another type of demonstrations was using teaching aids or "making things visible" through the use of convenient objects (in mathematics and physics one can often take objects from the classroom or even student bodies to illustrate shapes, three dimensional relationships, or interactions between atoms). Yet another type was to explore a phenomenon (such as induction current) by investigating the influence of various factors (windings of coil, movement of magnet with respect to coil, etc.) through an interactive demonstration. One could call this "process" or "inquiry" demonstrations. Obviously such interactive demonstrations require good classroom discipline and an open atmosphere.

Science in science teacher education: Mastery of school science (and subject specific pedagogy) should be number one and is a prerequisite for almost all teaching skills (from preparing a lesson, writing test questions, to investigating student understanding). Knowledge of common student alternative conceptions by the lecturer may guide the teaching/remediation of school science in the pre-service program as well as in in-service programs! Research of alternative conceptions has shown very clearly for both low and high-income countries that students entering university only partially comprehend many of the school science concepts. Even after university science courses many alternative conceptions persist. Therefore a preservice program should contain courses on school science (Aarons, 1990; McDermott, 1990).

In teacher education school science should be remediated in such a way that it is not perceived as plain repeating of school science courses, so the teaching should clearly deviate from the dominant mode. This is a good opportunity to expose students to alternative teaching methods and/or to model the way pre-service students are expected to teach later on. Furthermore, courses on teaching methods can be used also to improve school science mastery. In micro-teaching lessons deficient subject matter mastery shows clearly.

In short, before promoting relatively large changes in teaching strategies and curriculum goals, let's check whether prerequisite science and teaching skills are mastered. If so, then we can move forward past the basics. If not, first things (basics) first.

References


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<tr>
<th>Table 1: Improving conventional teaching</th>
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<td>• Mastery of school science with emphasis on conceptual aspects and examples and applications in the student's environment.</td>
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<td>• Increasing classroom interaction through questioning.</td>
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<td>• Training in interactive demonstrations with universally available equipment</td>
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<td>• Training in the use of Predict-Observe-Explain demonstrations</td>
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<td>• Making concepts more &quot;visible&quot; through use of common objects as teaching aids</td>
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<td>• Linking science with the local environment and technology</td>
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<td>• Teaching systematically through use of objectives and structure</td>
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<td>• Attention for individual students</td>
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<td>• Attention for student conceptions</td>
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<td>• Attention and feedback to student assignments</td>
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32

Science Education International, Vol. 5, No. 3 September 1994
Locally Produced Low Cost
EQUIPMENT FOR TEACHING OF CHEMISTRY
A monograph based on the work of the Edutronics Group, University of Delhi
Second Edition
K. V. Sane, University of Delhi
D. C. West, University of Mauritius

The monograph describes the fabrication, use and maintenance of three instruments (a pH meter, a conductometer and a colorimeter) having widespread utility for student level laboratory work in chemistry. Also described are the fabrication of two test instruments (a continuity tester and a OVA source which are useful either for trouble shooting or for calibration) and of several accessories like a magnetic stirrer, a zero-cost electrode for pH measurement, and a conductance cell. Brief theoretical sections in electronics and in chemistry are included to make the presentation self-contained. No previous experience in instrument fabrication is assumed; practical techniques like soldering, PCB making and circuit board assembly are consequently described in detail. The monograph is liberally illustrated and uses a highly visual style in which constant reference is made to the figures.

The equipment described in the monograph has been developed under the project entitled Low Cost Equipment For Chemical Education sponsored first by IUPAC CTC and UNESCO and then by the DST and by the UGC. Valuable assistance has also been received from IDRC, ICSU CTS, and from the Commonwealth Foundation. The immediate aim of the Project is to develop teaching-oriented instruments for chemistry which are simple, reliable, inexpensive, easy to fabricate, and easy to maintain. A wider aim is to influence the laboratory teaching by making it more purposeful, exciting and innovative. The know-how developed under the Project is, therefore, being disseminated through hands-on teacher training Workshops. Twenty-five such Workshops have been held outside India in every continent under the auspices of UNESCO while 35 Workshops have been organized all over India under the sponsorship of UGC.

The kits/equipment described in the monograph are being manufactured, under a DST License, by the Low-Cost Teaching Aid Charitable Society, 389/7 Dilkush Bagh, G. T. Karnal Road, Delhi-110033. The work-force of the Society—a Registered organization—consists of handicapped personnel and school dropouts trained by the Edutronics Group.

For more information contact:

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MOBILE MUSEUM LAUNCHED IN LUXEMBOURG

Children are discovering the world around them in an unusual way—inside a bus.

The new Musée Bus 2000, on show in the courtyard of the Foire International, made its first appearance in Troisvierges on 5 May. That a project under the auspices of the Ministry of Culture made its debut in a town so far from the capital is indicative of its purpose. The bus—which represents a 50 million franc investment—is designed to be a transportable laboratory, providing information about nature and science to people of all ages.

For many years, Luxembourg City's Museum of Natural History has offered guided tours of their exhibitions for school groups—but 43 communes out of the Grand Duchy’s 118 never took advantage of the offer simply because they were too far away from the capital city. It hardly made sense, for example, for a school in the far north of the country to take its students on a 90-minute journey to the museum for a two-hour tour, and then make another 90-minute journey back.

For this reason, the museum started taking exhibitions to various parts of the country a few years ago, but there were always the considerations of finding appropriate space for the displays and having to carefully transport the materials.

In 1991, following the examples of the 'Bibliobus' mobile library in Luxembourg and the 'Umweltmobil' environmental awareness bus in Schleswig-Holstein, the Ministry of Culture proposed the idea of a travelling museum of natural history.
The idea was approved, and the State provided roughly two-thirds of the needed funding—the rest came from private donators, Assurance Barthelemy, Eltrona diffusion, Electro-distribution Luxembourgeoise and the Enterprise Henri Bruch.

“The initial response to the bus has been very positive,” said Stéphane Risch, who is in charge of the project. “Children, in particular, are very interested in it, and if they are enthusiastic there will be a chain reaction—they will tell their parents and friends about it.”

Risch’s hope is that the bus—with its displays about different types of landscapes, animals, insects and plants—will educate both children and adults about the connection between their own lifestyles and the environment, and about the importance of preserving nature.

The mobile museum will tour schools free of charge and will be available for other interested groups for a small fee. The bus has space for 25 people at various work tables, has exhibition panels, stuffed birds and other animals, microscopes and binoculars.

Communes may hire the bus for cultural and educational activities, and clubs and other organisations may also rent the bus for a nominal fee. As the bus has just been launched exact prices and schedules have yet to be determined.

For more information, contact:  
Stéphane Risch  
Musée Bus 2000  
7, Rue De La Boucherie  
L-1247 Luxembourg  
46 76 60 or 47 93 30-249.

—Luxembourg News, 1994

The Musée Bus 2000 quickly turns into an interactive hands-on learning center.
Resources

RECENT ICASE PUBLICATIONS

The Status of Science-Technology-Society Education Worldwide

This 1992 ICASE Yearbook (140 pages), edited by Professor Bob Yager, University of Iowa, USA, has four sections: STS definition and rationale; Examples of STS initiatives; Evaluation of STS efforts; and STS in various countries.

Price—£5.00 ($8.00) plus 25% postage and packing.

Empirical Research in Chemistry and Physics Education

This book (195 pages) contains the papers presented in English at the biennial seminar on research in science education held in Dortmund, Germany, organised by Professor Dr. Hans-Jurgen Schmidt, in June 1992.

Price—£5.00 ($8.00) plus 25% postage and packing.

Sustainable Development for a New World Agenda

The World Environment, Energy and Economic Conference held in October 1990 in Winnipeg, Canada had as its main theme Sustainable development strategies and the new world order. The report of that meeting, with the main papers and discussion reports is now available as a major ICASE publication (250 pages), edited on behalf of ICASE by Professor John Penick, University of Iowa, USA. It contains a variety of viewpoints presented by specialists from many countries on the nature and complexity of problems associated with sustainable development and on educational strategies for introducing aspects of sustainable development into science curricula.

Price—£10.00 ($18.00) plus 25% postage and packing.

Education-Industry Partnerships

This is the report (125 pages) of the second ICASE European symposium, held in Arnhem, Netherlands in November 1992, on approaches to science education and industry liaison partnerships. The objective of the symposium was to strengthen the network of organisations and associations involved in industry-education links and to review the contribution of media and science centres towards the public understanding of industry and science.

Price—£5.00 ($8.00) plus 25% postage and packing.

Education in Science and Technology for Development

This is a report (260 pages) of a conference held in Trinidad in 1991 on the theme of science and technology education for development—perspectives for the 21st century. There are three sections: Issues in education; Curriculum and educational strategies; and Science and technology and education.

Price—£6.00 ($10.00) plus 25% postage and packing.

ICASE—The First 20 Years

This is the history of the first 20 years of ICASE from the beginning in 1973 until 1993.

Price—£5.00 ($8.00) plus 25% postage and packing.

ICASE Journal—Science Educational International

Published quarterly, the ICASE Journal is available at £10.00 ($17.50) per year for individual subscribers. Postage is included. The Journal has sections devoted to Science Technology and Society, Science Teacher Education, Primary Science and Research in Science Education, as well as feature articles and general news items.

Stepping into Science Newsletter

This is another quarterly publication from ICASE concerned with resource notes and practical ideas for primary school science. The annual cost of this is £5.00 ($8.00), including postage.

ICASE Publications may be obtained from the ICASE Treasurer, Knapp Hill, South Harting, Petersfield, GU31 5LR, UK.
POLLUTION PREVENTION
PROBLEMS AND SOLUTIONS

Edited by:
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Manhattan College, New York, USA

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Department of Civil and Environmental Engineering
Utah State University, USA

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Department of Chemical Engineering
Manhattan College, New York, USA

Engineering and science professionals have studied the management of hazardous and toxic wastes extensively, and it is clear that the principal option of the future will be waste minimization, or pollution prevention. At present, however, few practicing professionals have a working understanding of this approach, educators are just starting to teach course material in this field, and students are finally beginning to receive the necessary training to implement pollution prevention in their future work environment.

An applications workbook of more than 100 exercises, Pollution Prevention: Problems and Solutions covers a variety of topics closely relevant to this field. The lessons are organized into the categories of basic concepts, pollution prevention principles, regulations, source reduction, recycling, treatment, chemical plant/domestic applications, case studies and ethics.

The workbook is the result of a National Science Foundation College Faculty Workshop designed to generate new ideas and innovative educative approaches in the emerging interdisciplinary field of pollution prevention. Therefore, teachers and students of undergraduate and graduate courses on waste management will find the book especially useful, but decision makers and practicing professionals in industry can also appreciate this effective learning tool.

Pollution Prevention: Problems and Solutions
Price: $40.00/£00
Postage and Packing (per copy) $5.00/£3.00

Send to: International Publishers Distributor
PO Box 41010, Newark, NJ 07101-8007, USA
or PO Box 90, Reading, Berkshire, RG1 8JL, UK
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Calendar

1994-1996

1994

September 17-19, 1994

Fourth Interdisciplinary General Conference of Teachers on: "Light in Teaching Science and Technology"
Location: Czestochowa

The Fourth Interdisciplinary General Conference of Teachers is devoted to the many aspects of light in teaching scientific and technical branches.

September 24-29, 1994

WOCATE Conference
Sponsored by the World Council of Associations for Technology Education
Location: the University of Banska Bystrica, Slovak Republic
Contact: WOCATE Secretariat, Mrs. Doris Traherth, Schlosserstrasse 9, 90084 Erfurt, Germany

The conference is meant to discuss various aspects of innovation, production, small scale industry management and education. Especially those projects developed by companies that bring technology education, economy and management closer to young people. The possibilities for transferring special experiences in school-industry-link projects will be discussed.

October 13-15, 1994

NSTA Fall Convention
Location: Portland, Oregon, USA

Contact: NSTA 1994 Area Conferences, ATTN: T. Brent, 1840 Wilson Blvd., Arlington, VA 22201-3000

November 3-5, 1994

NSTA Fall Convention
Location: Minneapolis, Minnesota, USA

December 6-10, 1994

The 9th ICASE Asian Symposium
Location: Bangkok, Thailand
Contact: Dr. Janchai Yingprayoon, Secretariat: IPST Sukhumvit Rd. Ekamai, Bangkok 10110 E-mail: OICST@CHULKN.CHULA.AC.TH

The theme of the symposium is "INCREASING THE EFFECTIVENESS OF SCIENCE TEACHING IN THE CLASSROOM: A CHALLENGE FOR SCIENTIFIC AND TECHNOLOGICAL LITERACY FOR ALL."

December 15-17, 1994

NSTA Fall Convention
Location: Las Vegas, Nevada, USA

1995

January 4, 1995

ASE/ICASE International Symposium
Location: The University of Lancaster, UK

This will be held in conjunction with the ASE annual meeting.

January 5th-7th, 1995

The Association for Science Education Annual Convention
Location: The University of Lancaster, UK (which is 200+ miles north of London)
Contact: Dr. David S. Moore, General Secretary, College Lane, Hatfield, Herts. AL10 9AA
March 22-April 2, 1995

**United States Science Education Tour**
Location: Philadelphia, PA; Baltimore, MD; and Washington, DC.
Contact: Dr. Jack Holbrook, Executive Secretary, 72B Blue Sea House, 28th October Street, Limassol, Cyprus

The tour will feature various levels of science education, school visits and home stays with American families. Three days of the tour will be spent at the National Science Teachers’ Association Convention in Philadelphia, PA.

March 23-26, 1995

**NSTA National Conference**
Location: Philadelphia, PA, USA
Contact: NSTA 1994 Area Conferences, ATTN: T. Brent, 1840 Wilson Blvd., Arlington, VA 22201-3000

March 27-29, 1995

**Science Education Research in Europe**
Location: The University of Leeds, UK
Organised jointly by The Centre for Educational Studies, King’s College, University of London and The Centre for Studies in Science and Mathematics Education, The University of Leeds


April 7-11, 1995

**Science Education Research in Europe**
Location: The University of Leeds, UK
Organised jointly by The Centre for Educational Studies, King’s College, University of London and The Centre for Studies in Science and Mathematics Education, The University of Leeds


April 22-25, 1995

**NARST International Conference**
Location: San Francisco, CA, USA

Late June/Early July 1995 (exact date to be announced)

Location: Johannesburg College of Education
Johannesburg, South Africa
Organised by the STEME (Science, Technology, Environment & Mathematics) EDUCATION ASSOCIATION on behalf of the FEDERATION OF SCIENCE & MATHEMATICS TEACHERS.
Contact: Dr. Peter Glover
PO Box 32198
Braamfontein 2017, Johannesburg, South Africa

August 27th-September 1st, 1995

**Partners in Chemical Education An International Conference on Industry-Education Initiatives in Chemistry**
Location: University of York, York, UK
Contact: Miranda Mapleton
Chemical Industry Education Centre, Department of Chemistry, University of York, York, YO1 5DD, UK
Co-Sponsors: International Union of Pure and Applied Chemistry (Committee on Teaching of Chemistry) and Royal Society of Chemistry (Education Division and Industrial Division)

August 29th–September 2nd, 1995

**The International Conference on Industry – Education Initiatives in Chemistry**
Location: University of York, York, UK
Organisers: IUPAC Committee on Teaching of Chemistry
The Royal Society of Chemistry
University of York

The first major international conference sponsored by IUPAC which specifically aims to promote links and dialogue between concerned industrialists and teachers from higher education, secondary and primary schools, and educational decision makers; and to evaluate and encourage good practice and discuss issues of industry – education collaboration. Correspondence/Conference arrangements:
Dr. J. F. Gibson
The Royal Society of Chemistry
Burlington House, Piccadilly
London WIV OBN
UK
Tel: +(44) (0) 71-437-8656
Fax: +(44) (0) 71-734-1227

September 4-15, 1995

**Fourth World Conference on Women**
Location: Beijing, China
Contact: Conference Secretariat: Division for the Advancement of Women, PO Box 500, A-1400 Vienna, Australia Tel: 431/21131, Ext. 4270;
This conference will:
1) review and appraise the advancement of women since 1985 in terms of the objectives of the Nairobi Forward-looking Strategies for the Advancement of Women to the Year 2000.
2) mobilize women and men at both the policy-making and grass-roots levels to achieve those objectives.
3) adopt a "Platform for Action," concentrating on some of the key issues identified as representing a fundamental obstacle to the advancement of the majority of women in the world. It will include elements relating to awareness-raising, decision-making, literacy, poverty, health, violence, national machinery, refugees and technology.
4) determine the priorities to be followed in 1996-2001 for implementation of the Strategies within the United Nations system.

September 24-29, 1995

CONASTA 44
Location: University of Queensland, Brisbane, Queensland, Australia
Contact: David Tulip, Centre for Mathematics and Science Education, Locked Bag No. 2, Red Hill, Queensland, Australia. E-mail: D.Tulip@qut.edu.au
Tel: +64 7 864 3345 or Fax: +64 7 864 3985.

While the conference program is not finalised at this stage, it is envisaged that it will include theme lectures, symposia based on science education and workshops either based on current science research or science classroom practices. All symposia and workshop sessions will allow for personal choice and will cater for Primary, Secondary and Tertiary science teachers and science teacher educators. Educational tours of the Great Barrier Reef, tropical and subtropical rainforest, whale watching and other unique geographical and biological features of Queensland, will also be offered three to seven days prior to or immediately following the conference. A detailed synopsis of the speakers, a framework of the conference activities and a call for abstracts of papers will be available by July 1994.

September 25-29, 1995

3rd European Conference on Research in Chemical Education
Location: Lublin (Poland)

Contact: Department of Chemical Education, Maria Curie-Sklodowska University, PL.M.C. Sklodowskiej 3, 20-031 Lublin, Poland, dr Ryszard M. JANIU LIK Tel: (81) 37-56-91 Fax: (81) 336-91 e-mail: JANIUK@PLUMCS11

The previous two conferences were held in Montpelier, France in 1992 and in Pisa, Italy in 1993. The next conferences are planned to be held every two years. The conference in 1997 will be held probably in UK. The organizers of the conference are the Federation of European Chemical Societies and the Chemical Society of the country in which the conference is held.

1996

March 28-31, 1996

NSA National Conference
Location: St. Louis, MO, USA

July 14-19, 1996

14th International Conference on Chemical Education
Location: Brisbane, Australia
Contact: The ICCE Conference Secretariat (Sally Brown), Continuing Professional Education, The University of Queensland 4072 Australia
Tel: (07) 365 6360 Intl: +61 7 365 6360 Fax: (07) 365 7099 Intl: +61 7 365 7099
E-mail: chemed96@ceu.uq.oz.au

The 14th ICCE will be held in Brisbane from July 14-19, 1996. It is only the second time this conference has been held in the southern hemisphere. The biennial conference brings together chemistry teachers, chemists and science educators from school, industry and university settings to share ideas and learn from one another about innovation in teaching and learning and the discipline of chemistry. The theme, Chemistry: Expanding the Boundaries, acknowledges the centrality of chemistry through its expanding relationship with many facets of science and everyday life. Conference participants will be challenged to develop this theme with the view of enhancing our understanding of the important relationships which chemistry forms with the new frontiers of human endeavour. Implications for chemical education beyond 2000 which give a "science for all" perspective will be encouraged.
Extending and Improving Education in Science
for All Children and Youth by Assisting
Member Association Throughout the World

EXECUTIVE

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<tr>
<th>Name</th>
<th>Position</th>
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<tr>
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Science Education International is the Quarterly Journal of the International Council of Associations for Science Education. ICASE was established in 1973 to extend and improve education in science for all children and youth by assisting member associations throughout the world.

This journal provides a means for associations, institutions, centres, foundations, companies and individuals concerned with science education, to share perspectives, concerns, ideas, and information which will foster cooperative efforts to improve science education, and which will serve as a chronicle of the advancement of science education throughout the world.

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ICASE News
ICASE Welcomes New Member

Feature Article
World View, Culture, and Science Education
Defining "Interdisciplinary": Creating an Effective Team for Middle Level Instruction

Science Education Around the World
Integrated Science Teacher Education in Nigeria: How Effective Is It?
A Chilean Approach to Preparing Secondary School Science Teachers

Research on Curriculum,
Teaching & Learning
How To Change Tellers to Tillers: Needed Research in Science Education in an Era of Major Reform

Teaching Materials & Strategies
Student Self Evaluation: The Learning Process

Science Teacher Education & Leadership
Teachers' Resource Centre: A Place for Teacher Learners

Assessment and Evaluation Trends
The Third International Mathematics and Science Study: An Overview

Non-formal & Informal Science Education
Teaching and Learning Through Interactive Media Exhibition

Calendar

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Science Education International, Vol. 5, No. 4 December 1994
ICASE WELCOMES NEW MEMBERS

ESTONIAN ASSOCIATION OF CHEMISTRY TEACHERS

The Estonian Association of Chemistry Teachers (EACT), which began in the '70s, was created to facilitate annual meetings of chemistry teachers. Most of those annual meetings have been international, with participants from Russia, Latvia, Lithuania, Armenia, Finland, Sweden, Denmark, the Netherlands, and Germany.

Members of the EACT include chemistry teachers, university lecturers and education officials. The number of active members is approximately 100.

The aims of the EACT are as follows (from the statutes):

- to promote creativity and social activities of chemistry teachers;
- to collect and distribute the latest information on chemistry, teaching of chemistry, research work in the field of didactics of chemistry;
- to organize special culture—education seminars, exhibitions, etc., activities;
- to establish contacts between chemistry teachers and organizations, universities, companies and private persons in Estonia as well as abroad and promote co-operation;
- to assist members of the EACT with up-to-date teaching materials;
- to organize inservice training of chemistry teachers;
- to organize various economic activities, to support projects concerning improvement of chemistry teaching and their training;
- to protect the rights and interests of the members of the association.

Main Activities and Goals

EACT is looking for co-operation with the associations of science teachers of other countries. EACT welcomes other associations to participate in inservice training, seminars, introduction with Estonian industry, etc. We are planning to collect all kinds of publications in the field of science education.

EACT has published methodological collections for teachers and teaching materials for students.

One of the aims is to increase students’ interest in chemistry. Consequently, there is a club of young chemists which prepare performances for other schools (during the last two years there have been about 20 performances).

EACT has good contacts with the Finnish association of science teachers. Through cooperation with teachers from Vantaa (Finland), a joint seminar was organized in 1993. Teachers from Vantaa also participated in the summer camp for environmental research organized by students. The near future, we plan to organize national olympiade in chemistry for students where the level of the tasks enables students without special training to participate.

The members of EACT have organized for students different kinds of summer camps (in 1994 an environmental camp for students from three schools of Estonia was organized).

For more information, contact:
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THE “SCIENCE TEACHER EDUCATION PARTNERSHIPS (STEP) CENTER”: AN INTRODUCTION AND OVERVIEW

Introduction

A proposal for the creation of a “Science Teacher Education Partnerships (STEP) Center” was prepared by M. O. Thirunarayanan, an assistant professor in the School of Education, and approved on September 21, 1993.
Major Goal of the STEP Center
The major goal of the STEP Center is to initiate and sustain mutually beneficial and long-term partnerships between the School of Education at Indiana University-Purdue University Fort Wayne (IPFW) and various formal and informal science education agencies such as the Fort Wayne Children’s Zoo, Science Central and school systems in Northeastern Indiana. The primary emphasis of such partnerships will be on the preservice and inservice education of science teachers.

Objectives of the STEP Center
The objectives of the STEP Center are as follows:

i) to provide a forum for the facilitation of partnerships between IPFW and various formal and informal science education agencies such as Fort Wayne Children’s Zoo, Science Central, school systems in Northeastern Indiana, and other appropriate agencies;

ii) to offer ongoing professional development opportunities for preservice and inservice science teachers; and

iii) to facilitate communication and interaction among various agencies involved in and interested in the preservice and inservice education of science teachers.

Activities of the STEP Center
In order to achieve its goals and objectives, the STEP Center will:

• Organize workshops and seminars for inservice and preservice science teachers on various topics related to science education (e.g., energy education, environmental education, hands-on approach to teaching science, authentic assessment, technology in science education, using toys to teach science);

• Arrange talks and presentations by visiting experts from other universities and by experienced master teachers;

• Publish a newsletter;

• Establish and maintain a collection of science education resources, such as books, CD-ROMs, computer software, films, interactive videodiscs, journals, kits, and videotapes;

• Create placement opportunities for preservice science teachers in museums, zoos and other informal science education agencies;

• Identify and provide job-shadowing opportunities for preservice science teachers in research laboratory settings;

• Conduct summer institutes and workshops for preservice and inservice science teachers;

• Organize special events such as conferences for inservice and preservice science teachers;

• Involve preservice and inservice science teachers in developing activities, lessons, units and other ideas for implementing the recommendations of the National Science Education Standards; and

• Establish and maintain an electronic bulletin board to facilitate communication among partners.

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INTRODUCING ALMAWRID

The idea of establishing a center that facilitates the professional development of teachers has emerged as a reaction to the deteriorating educational situation and the general plunge in the quality of education in the West Bank. Almawrid Teacher Development Center was established to empower teachers to ameliorate the present educational situation, and to develop the educational system by making it more responsive to the needs of the Palestinian Community.

The Center believes that the teachers have to play a major and active role in developing the educational system, and that any steps towards improving this system would be unrealistic and futile if they ignore the teachers. Consequently, the Center has attempted to provide a suitable environment for teachers to meet, discuss problems, suggest and implement solutions and educational projects.

The Center focuses on activities that allow teachers to exchange knowledge and experience, to reflect collectively on their teaching practices, and to clarify, evaluate, test, and modify their beliefs. Consistent with this emphasis, the Center is organizing different workshops for the teachers of different school subjects.

During the academic year 1992/1993, teachers of mathematics have produced student worksheets, while English Language teachers produced a booklet for teachers that deals with pedagogical issues in
teaching English for fifth grade. Science teachers, on the other hand, produced a group of activities for teaching the topic of sound for grade nine.

During the academic year 1993/1994 ninth-grade teachers of science, mathematics, Arabic language, and social studies are meeting on a weekly basis to plan how to teach the newly introduced curricula in these subjects and evaluate the implementations. The Center provides to each group subject-matter and educational consultants. Courses for enhancing various teachers' competencies are offered at the Center. One of the most attractive courses has been a basic computer literacy course.

In addition to this, the Center has established a workshop and a library in order to provide the material resources teachers need. Teachers are allowed access to the workshop to produce instructional materials and to design school science experiments. The library is to be developed to hold subject-matter and educational books and references, school curricula from other countries, and video cassettes. Teachers are given borrowing privileges to most of the library materials.

Over the last year a significant number of teachers participated in the activities of the Center and used its facilities. This vindicates the philosophy of Almawrid and encourages the Center to continue and develop its work.

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Post-Graduate Certificate of Education which leads to UK Qualification Status. Science Education Lecturers based in the Cecil Powell Centre teach the M.Ed. in Science Education programme which attracts students from overseas and at home and the Centre is also used by the Department of Continuing Education in the University for its science programmes.

The Centre for International Studies in Education was set up in 1989 as a development from the Centre for Overseas Studies in recognition of the long-established work in professional studies and research carried out in the School of Education for overseas governments and with overseas students. There is a strong programme of taught M.Ed. modules which focuses on development issues and the management of curricular and other changes and currently staffed from the Centre for International Studies, which includes those from the Cecil Powell Centre for Science Education, are undertaking work in 10 countries.

Both the Cecil Powell Centre and the Centre for International Studies welcome enquiries and visitors world-wide and are happy to discuss proposals for study and/or research. For further information, please contact:

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THE CECIL POWELL CENTER FOR SCIENCE EDUCATION

AND

THE CENTRE FOR INTERNATIONAL STUDIES IN EDUCATION

The Cecil Powell Centre for Science Education is part of the School of Education in the University of Bristol, UK. Named after one of the University’s Nobel Laureates, it was established nearly 30 years ago to facilitate the education of science teachers, both preservice (initial teacher education) and inservice (professional development). Currently 60 science graduates are undertaking the

FOOD FOR THOUGHT
To Double Your Success
You Must Double Your Failures.
WORLD VIEW, CULTURE, AND SCIENCE EDUCATION

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In the last few years many science education policy documents, including those from Project 2000+, have noted the need for further knowledge and understanding of how people individually and as members of social and cultural groups learn and teach science. To this end science educators have studied cognitive development and mental capacity. They have explored the effectiveness of various instructional strategies. Among other things they have investigated the errors students make. However, what students believe about the physical world, belief rooted and nurtured in students’ socio-cultural environments, has received far less attention. In a non-Western economically developing nation one speaks of traditional culture in contrast to the culture of science where educators understand that science is a second culture for students. In Western nations such as the USA science educators have long assumed that scientific explanation is a natural part of student culture. But this is not necessarily a wise assumption. Many Western societies are increasingly pluralistic. Moreover, not only is there widespread disinterest in science among Western students, there are several cultural subgroups traditionally under-represented in science. In the USA these include, for example, women, African-Americans, Hispanics, American Indians, and those who are religious conservatives.

Cultural Studies

Bearing in mind the significant differences between nations east and west, north and south, economically developed and developing, it is perhaps time for science educators to consider the possibility that science is a second culture experience for most students regardless of where they live. What I have set out below is a brief discussion of cultural research in science education based on a world view. The study of culture has typically been the bailiwick of the cultural anthropologist. However, scientists, historians, and literary critics among others, have in recent years joined the study of culture. What unifies these eclectic cultural scholars is that they “take a subject whose working assumptions are considered natural and attempt to demonstrate that they are culture-bound” (Heller, 1989, p. A8).

We live in a rich experiential world brought to us by our senses. But the data of our senses is an amorphous mass of confusion until interpreted by our world view. Sociologist Peter Berger (1979) argued that a people’s world view provides a special plausibility structure of ideas, activities and values which allows one to gauge the plausibility of any assertion. This shared world view is a fundamental aspect of any cultural group. In my view, science education has a cultural identity of its own, and teachers typically assume that students operate within the plausibility structure accompanying that identity (Cobern, 1991 & 1993a). The original notion of heretic was someone who decided things for himself instead of employing society’s plausibility structure or world view. I suspect that science classrooms are filled with heretics operating within other plausibility structures, and that many can be recognized by their alleged misconception.

Talk of misconceptions . . . carries with it the suggestion that something has been botched or bungled, or that something has gone amiss . . . And there is often the further implication that the student is the culprit: that he or she is the one who has gotten something wrong . . . There is more to error than meets the eye (Hills, 1989, p. 174).

Indeed, there is more than meets the eye. Young children in the classroom are in the process of world view and plausibility structure formation. What was long known about children in cultures outside the West is now being found to equally apply to children in countries like the USA; that is, that school does provide the principal, let alone the sole influence upon this formative process (e.g., Phelan, Davidson, & Cao, 1991).

Moreover, with young children one is not likely able to separate world view development from other aspects of conceptual development. World view theory supports those researchers whose interest is in the contexts of meaning in which children construct.
knowledge. Bloom (1989a) noted that, “children’s thinking is guided by an ever-changing variety of knowledge, frameworks of belief, mental processes, and emotions” (also see Bloom, 1989b). In the literature anthropocentrism, anthropomorphism, and zoomorphism have all been given as examples of children’s frameworks of belief. Science educators will likely find that these types of belief in children adumbrate world view presuppositions to come. In childhood however, it would be a mistake to see world view as a distinct conceptual development. Older children on the other hand come to class with well developed world views. These students enter the classroom with culturally validated ideas about the world. But again, the principal formative agent is not likely to be the school. Because the school is not the principal agent, educators tend to pejoratively label students’ views as misconceptions.

As noted by Smolich and Nunan (1975), Nadeau and Desautels (1984), and Duschl (1985), science education has long been dominated by a scientific perspective central to which is that science is above culture. Thus, the only concern of science with culture is that culture not hinder science. From this perspective, the first objective of science education is the elimination of all traditional thought that is deemed a hindrance to science, and of course, to replace that traditional thought with scientific thought. In other words, science education is quite imperialistic. The early work done on teaching for conceptual change, though probably unintentional, was based on this view. It was argued that conceptual change would take place when students saw that scientific explanations were superior to the untutored, commonsense beliefs brought by students to the classroom (Posner, Strike, Hewson, & Gertzog, 1982). Researchers quickly discovered that it is not that easy to demonstrate the superiority of scientific explanations. Conceptual change approaches tend to work best with students who already share the plausibility structure of the science teacher and the science textbook. It is ironic then that a frequently stated goal of science education is to develop a scientific outlook or scientific world view, for it seems to me that this goal is tacitly presupposed by much of science instruction.

Of late science education researchers have embraced constructivist ideas (Yager, 1993). Constructivist thought breaks with traditional science education thought in that science and culture are seen as inseparably linked. The constructivist view is that science always exists in a cultural context and that the cultural matrix of science education in which science is embedded may not be one widely shared by students. This does not mean that science is relative. Science content is science content regardless of culture to be sure, but not so with its communication nor the policies that support and direct science. In the jargon of education, there is always hidden curriculum and this raises three issues. The first is the frequently cited concern that traditional culture hinders science education. The second and third issues are much less discussed. While a traditional culture might hinder science education there is as well the potentially adverse influence of an alien hidden curriculum on the integrity of a traditional culture. Moreover, a hidden curriculum may in fact adversely influence science education among those who are alienated by the hidden curriculum.

I understand that culture changes. Any new idea brings change as people in a host environment react and adapt to new ideas. Modern science will influence a non-Western culture as surely as it has influenced and continues to influence Western culture. The concern is not cultural change per se, but unwarranted change. Must African nations, for example, adapt to science and adapt science to African culture exactly as the West had done? This concern arises first because relatively speaking modern science and science education are newly imported phenomenon in the cultures of most developing countries. And, science is indeed a powerful cultural force. Moreover, as educators around the globe adopt the Project 2000+ goal of scientific and technological for all, M. F. D Young’s (1976, p. 53) comment of seventeen years ago bears repeating:

school science separates science from pupils’ everyday lives, and in particular their non-school knowledge of the natural world. It is learnt primarily as a laboratory activity, in a room full of special rules, many of which have no real necessity except in terms of the social organization of the school.

And though Young wrote these words in 1976, recent work demonstrating the importance of everyday thinking (e.g., Cole, 1990) shows that the significance remains current. If science educators can come to a better understanding of the different everyday ways that people have of viewing the world and why they have those views, perhaps the structure of science education can be changed so that Young’s separation is closed.

To this end the following questions need to be addressed by science educators for the communities and societies in which they live.

1. What do students believe about the world around them, especially the physical world?
2. How do students understand their own place
in the world, especially their relationship to the physical world?

3. What is the cultural milieu in which these student beliefs, values, and relationships are grounded and supported?

4. What is the culture of science and how is that culture interpreted in the school science classroom?

5. What happens when student cultures, teacher culture, and the culture of science meet face to face in the classroom?

6. When science is resisted, is it the science people object to or is it the context of the science?

7. When pupils are influenced by science education, are they influenced solely by science? Or, are they influenced by science plus the context in which it is presented?

In other words, it is important for science educators to understand the fundamental, culturally based beliefs about the world that students bring to class, and how these beliefs are supported by students’ cultures; because, science education is successful only to the extent that science can find a niche in the cognitive and socio-cultural milieu of students.

World View Theory

World view, which offers one approach to these questions, is a concept borrowed from cultural anthropology. It refers to the culturally dependent, generally subconscious, fundamental organization of the mind. This conceptual organization manifests itself as a set of presuppositions which predispose one to feel, think, and act in predictable patterns.

Kearney (1984, p. 1) referred to world view as: culturally organized macrothought: those dynamically inter-related basic assumptions of a people that determine much of their behavior and decision making, as well as organizing much of their body of symbolic creations... and ethnosophology in general.

To be rational simply means to think and act with reason, to have an explanation or justification for thought and action. Such explanations and justifications ultimately rest upon one’s world view. Thus, world view is about epistemological levels antecedent to specific views that students hold about physical phenomena, whether one calls those views commonsense theories, alternative frameworks, misconceptions, or valid science.

In 1984, Brent Kilbourn pioneered the use of world view in empirical science education research by using Pepper’s (1940) root metaphor approach. More recently, logico-structuralism was adapted from cultural anthropology for use in science education research (Cobern, 1991). The power of the logico-structural model of world view lies in its composite structure of inter-related, universal categories: Self, Non-self, Classification, Relationship, Causality, Time and Space (Kearney, 1984). Each category is composed of logically related presuppositions. In principle groups of people and even individuals can be identified by world view variations which result from the content variation of categories. This composite nature of the logico-structural model focuses the researcher's attention on the complexity of world view, and yet the categories themselves provide access to that complexity. And while the composite nature of the model makes it less likely that the researcher will oversimplify the notion of world view, one can still speak of world view unity based on salient presuppositions within the seven universal categories.

In a recent study based on logico-structural theory, I investigated the contrasting conceptualizations of nature held by college biology professors and women students who were successful in the biology courses but were not science majors (Cobern, 1992 & 1993b). The study is an example of a different way of looking at students and teachers prompted by world view theory. In the study it was found that students and professors can be summed up with the phrase, depth versus breadth. In the research interviews the professors very quickly began to talk about nature in scientific terms and in quite some depth. In contrast, student conversation contained little science but ranged broadly over topics from religion to aesthetics to emotional states. It is not surprising that a biologist without any prompting would voluntarily choose to speak of nature in biological terms. Nevertheless, when laid side by side the difference between the student and professor conceptualizations of nature, one of breadth versus depth, is striking. One cannot help but wonder how such divergent viewpoints interact in the classroom and with what consequences. Of course, this is exactly the direction of future research (Cobern, 1992 & 1993b); and ultimately, the value of logico-structural world view theory in science education will rest on the fruitfulness of the research it precipitates, and the understanding of culture this research provides.

Classroom Application

The first thing for teachers to remember is that the interaction between culture and science education is rarely evident in a single teaching episode. It is an interaction that manifests itself over a period of time. It is not nearly so important to construct a culturally sensitive lesson as it is a culturally sensitive
curriculum. Therefore, over the course of a teaching year teachers need to find ways of encouraging their students to grapple with the problem of forming a culturally authentic view of science. My immediate suggestion is that teachers frequently ask of themselves the seven questions listed earlier. In so doing they will prompt themselves first to monitor the cultural appropriateness of their own instructions and second to monitor the opportunities they are affording their students to engage in a cultural dialogue with science.

References

FOOD FOR THOUGHT

Science Process Skills
Observation
Measurement
Prediction
Inferring
Classifying
Communicating
Formulating Hypotheses
Designing Investigations
Collecting and Interpreting Data
Recognizing Variables
Defining Operationally
Formulating Models
Using Time/Space Relationships
DEFINING “INTERDISCIPLINARY”: CREATING AN EFFECTIVE TEAM FOR MIDDLE LEVEL INSTRUCTION

by

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Introduction

I remember when I realized that “real” learning wasn’t necessarily about what I read in textbooks or observed in a classroom. I was in the sixth grade at the time, and the high school science club was going to take my class to a local campground to help us learn about science in our world. I couldn’t really fathom that high school kids knew as much as Mrs. Shea, my teacher—at least in science.

Science was what happened in Mrs. Shea’s room. Hadn’t we already learned about rats by raising one? Learned about plants by growing them? Learned about crystals by providing conditions so that they could form? What could high school kids possibly teach me about science?

My friends and I were nonetheless excited about the whole concept when we jumped off the bus. Not particularly about science, mind you, but there were other factors. No classrooms. Mud. Cute high school boys. Canoes. Bunkbeds. Dumb sixth grade boys. Above all else, this was going to be fun. We were going to have An Experience.

Now, almost fourteen years later, I mainly remember that they did have something to teach me. I do remember the high school kids getting in trouble for running off somewhere during the campfire, but I remember being amazed at the little organisms swimming around in pond water, that a blackbird compared to a black bird with an orange swish are not the same, that moss has a tendency to grow on one side of a tree more than another, that I could write poetry about insects, that I could imagine how it would be if I were a pioneer traveling without a compass, and on and on.

I also remember that in high school I signed up for science club because I knew that I could teach sixth graders something about science that maybe Mrs. Shea’s classroom couldn’t. Looking back, I remember the countless hours spent after school planning and creating with fifty other students to make sure the two days had something for everybody, including us (since we were in charge of it). And including science.

If nothing else, I learned about science then, too. But this time I realized that science worked with a whole bunch of areas. Science was found in the kitchen with why yeast is important and how it rises. Physics and physical education were found standing up in (and falling out of) a canoe of water. Anatomy and mathematics and linguistics were combined when we tried to guess how many more giant marshmallows Mrs. Sykes and Stuart Zetterman could each stuff into their mouths while trying to say “fuzzy bunnies.” Science was found with English and music in the songs and stories shared around the campfire. Astronomy was linked to English again as we struggled to find different mythological creatures in the stars. And on and on.

What brought these memories back was that, as a teacher of middle level students, I am in the process of trying to make my curricula as dynamic as possible, and I believe that means I need to apply it to the real world. The problem is that seldom is the world divided into neat curricular areas. I started thinking that some of the things I wanted to try overlapped with other subjects taught in isolation at my school. What I am interested in is making my teaching more integrated for my students to learn, retain, and apply to their own lives.

In the reformation of middle level schools, there are several key components, one being interdisciplinary education. Indeed, as Roberts (1993) states, “At no other level of the student’s development nor in the organization of schooling is the concept of holistic and interdisciplinary learning more likely to take root and flourish” (p. 39). Since the focus of the middle school education is on students, the interdisciplinary approach is a convenient way to make the middle level program match students’ needs (Roberts, 1993).

How schools and educators define “interdisciplinary” will ultimately show the extent to which they implement the interdisciplinary approach. According to Webster’s Ninth New Collegiate Dictionary (1987), interdisciplinary is defined as “involving two or more academic, scientific, or artistic disciplines” (p. 630). One step above this is interdisciplinary instruction, commonly referred to as IDI, which Mitman and Lambert (1993) define as a type of teaching which “demonstrates relationships...
between two or more disciplines so as to foster student understanding of important problems, issues, or themes" (p. 510). Finally, Mac Iver and Epstein (1993) define interdisciplinary teams as “composed of colleagues who teach different subjects to the same group of students” (p. 526).

Not all educators have come to an agreement on the definitions of the above descriptors, which may be a reason that the interdisciplinary approach is constantly under scrutiny and may also be a reason that there is such a lack of research on which disciplines constitute effective interdisciplinary teams at the middle level (Plodzik & George, 1989).

Teams are one way to implement the interdisciplinary approach, but how and why these are organized should be a concern for the total staff as well as the community. Most frequently, teams consist of four core teachers—social studies, English, science, and mathematics, although teams may range from two to five teachers in a variety of subjects (Mac Iver & Epstein, 1993; Vars, 1987).

There are natural links between core subjects to which interdisciplinary teams address, but these core teams often overlook courses essential to middle level philosophy: the exploratories. By laying other departmentalized subjects next to the core, certain links also appear. Art, computers, business, foreign language, technology, and health are a few areas that can easily integrate with the core areas. Even Erb (1991) states, “The curriculum should not be organized around basic and exploratory classes but around the notion that the common core, exploration and special interests should be integrated into every aspect of the middle grades program” (p. 26).

**Effects of interdisciplinary teams**

By examining problematic or controversial topics which are meaningful to students, teachers are “expected to help students make wise decisions in these crucial matters based on thoughtful examination of the alternatives and their consequences” (Vars, 1987, p. 16). When departmentalized teachers are expected to do this by themselves with many students, they may end up feeling frustrated. Thus the teaming component comes into play with middle level philosophy. When a group of teachers share common students, they can work together to create measures and alternatives which are in the best interest of the student.

What does all of this mean for the structure of effective middle schools? Research has shown benefits for interdisciplinary teams and also pointed out the drawbacks of only using core interdisciplinary teams. Going back to the premise that the interdisciplinary approach is only one way of looking at middle level instruction instead of the only way, what are characteristics of effective teams—teams which go beyond core studies?

**Characteristics of effective middle level interdisciplinary teams.** Unfortunately, there is a lack of research specifically directed toward middle level education as to which subjects (or if all subjects) constitute an effective interdisciplinary team. There tends to be more literature addressing problems with creating effective teams.

According to Mitman and Lambert’s (1993) study, teachers identified seven main obstacles in their development of interdisciplinary curricula which had direct impact on team effectiveness: lack of plan time, scarcity of materials, difficulties in sequencing and timing of units, relating themes to more than two disciplines, poor participation, lack of principal monitoring, and lack of teacher self-evaluation.

However, one key report by Plodzik and George (1989) determined the level of development of seventh grade interdisciplinary teams in New England middle schools. Principals of 159 out of 311 middle schools in six states completed questionnaires which indicated the presence or absence of 28 team behaviors associated with George’s Four Phase Model.

Seventy percent of the principals stated interdisciplinary team organization existed in their schools. Actual composition of those teams was not given, but as a whole, the teams had a median of four teachers. Following the sample study, telephone interviews were conducted with 20 principals as to what factors contributed to their effective teams. Flexibility, academic strength, desire to be a team member, and knowledge of the middle school child were all significant characteristics of middle level teachers influencing team growth. Common plan-time, clearly-stated expectations by the administration, and team building strategies were other factors in aiding effective teams.

What this study meant for middle level was a validation of literature dealing with opinions and generalizations by middle level theorists and practitioners (Clark & Clark, 1987; Vars, 1987) because “the confusion for the middle school teaching team often occurs over just what our stuff is. Is it students? Is it discipline-based knowledge? Is it both or something else altogether? We must learn to dialogue in such a way that our stuff becomes explicit, agreed upon. It is not enough to build interdisciplinary teams because the current descriptions of middle schools all call for them; we have to know what the stuff of those teams is” (Kain, 1993, p. 29).
The whole idea of an effective interdisciplinary team is working together to create the links of education appropriate for students’ needs. Yet few middle level teachers have been specifically prepared for interdisciplinary planning and teaching (Vars, 1987). Mitman and Lambert (1993) elaborated Vars’ point by stating, “Indeed, across-subject teacher teams are often organized as a first step towards facilitating interdisciplinary instruction, although the existence of teacher teams is no guarantee that meaningful connections across disciplines will be designed” (p. 510).

Since teams can only be as effective as the people who work on them, who is on the team becomes an important issue in effectiveness (Arhar, Johnston & Markle, 1989). Maeroff (1993) goes forward with that thought by saying, “At a time when schools are replete with talk of cooperative learning—an approach that calls for teachers to teach groups of students collaborate in their learning—there is no concomitant move to encourage collaboration among professionals” (p. 514). Therefore, it really doesn’t matter which subjects are represented on a team. What is more important is that “teaming needs support of teachers, so involve teachers carefully. Use core teachers, elective teachers, and school staff in the selection and development process to enhance communication and articulation of expectations” (Smith, 1991, p. 21).

Clark and Clark (1987) caution about including too many people on a team due to more difficult management, planning, scheduling, grouping, integration, and facilities use. They also warn that “team members should not expect to integrate all the concepts in the respective subject areas. Rather, team members should examine the content and look at areas that are easily integrated” (p. 2).

Conclusions

There are many ways of organizing the interdisciplinary approach. Ideally all subject areas (including exploratories) should integrate to make related learning that is appropriate for the middle level student. However, there are numerous factors that hamper the formation of such a team. Furthermore, educators need to come to a consensus on a specific definition for the interdisciplinary approach so primary, middle, and high schools can easily identify and relate to the concept without confusing other approaches with which they are more familiar.

Secondly, making connections for middle level students is a vital part of middle level education and the interdisciplinary approach can be one exciting way to meet this goal. By asking students to evaluate an interdisciplinary unit for the benefit of others gives the student a sense of power as well as allowing the students to help in planning the unit is currently a little used strategy. Teachers and students can attain benefits from an interdisciplinary approach, but it does not necessarily benefit all students, and teachers must really communicate and cooperate to attain theirs.

Next, administrators who may have inadvertently formed teams based solely on core subjects may want to evaluate teams to see how effective they are for students’ needs. Furthermore, efforts should be made to explore options for other types of teams as well as departmentalized instruction for all interested teachers. While problems with scheduling a common plan time might hamper a team’s effectiveness, other factors are also involved and both the team and the administrator should be aware of these in order to keep a good team strong.

Finally, the serious lack of research dealing with effective interdisciplinary middle level teams and their effects of students needs to be addressed. Organization, implementation, and evaluation of teams by teams can be as invaluable to the entire school as to the middle level reform movement. For now, the interdisciplinary team approach must be given time and commitment in order to see the overall effects and possibilities it has for learners.

There is no answer based on the research as to why exploratory teachers are not included on core teams. Several reasons have been alluded to this question, but no studies have pursued this specific question. By researching this area, perhaps more insight would be gained about the interdisciplinary approach as a whole.

References


**DISCREPANT EVENTS**

Ed van den Berg

The June 1994 issue of Science Education International contained an interesting article on discrepant events by Gvindarajan and Wright. I would just like to list two additional resources for using discrepant events in teaching:

a) *Invitations to Science Inquiry* is a book containing instructions for over 400 discrepant event demonstrations most of which do not require any special science equipment. I have used earlier editions of this book for 14 years in Indonesia and in the Netherlands in science courses as well as pre-service and in-service teacher education. Our teacher education students in Indonesia used the book as a resource for microteaching assignments and practice teaching in the schools, even though usually they avoided English language books. We did provide special training in the use of discrepant events in one of our teaching methods courses. The book also constitutes a popular resource for in-service activities. Most demonstrations concern junior and senior high school physics and chemistry. There are some big demonstrations for Earth Science and Biology. Complete information for ordering is as follows:

T. L. Liem: *Invitations to Science Inquiry* (2nd edition). Published by Science Inquiry Enterprises, 14358 Village View Lane, Chino Hills, California 91709 (telephone: 909-590-4618). The book is also available through the National Science Teachers Association in Washington. The list price is $45.00, however, discounts for bulk orders and for orders from developing countries seem to be possible. The ISBN number is 1-878106-21-X.

b) A chapter in the book *Probing Understanding* by Richard White and Richard Gunstone gives excellent suggestions for when and how to use discrepant events in teaching (called Predict-Observe-Explain demonstrations). The book is an excellent resource for courses in teaching methods with various techniques to probe the understanding of students such as concept maps, interviews and how to analyse them, student drawings, etc. I use the books as a graduation present for my teacher education students. However, I give the book long before graduation so we can still use it during the teaching practice. The complete reference for ordering is:

INTEGRATED SCIENCE TEACHER EDUCATION IN NIGERIA: HOW EFFECTIVE IS IT?

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Abstract
This paper, the first of two papers, seeks to describe the background of and research into integrated science teacher education in Nigeria and to compare the teacher training programs with the practice in schools. The paper describes, too, the development of integrated science curriculum in schools and how pupils and teachers have responded to it. It goes on to identify the need for research into the match between teacher training and curriculum demand in integrated science in Nigerian schools. By means of questionnaires and interviews in schools, colleges and universities, data have been collected which describes the views and practices of teacher trainers, classroom teachers and student teachers in some Nigerian institutions. This paper concludes by summarizing the research methods.

Introduction
The wind of change of science curriculum reform that blew across the world in the '60s and '70s, particularly in the area of developing new and suitable science curricula for the primary schools and junior classes of the secondary schools, led to the emergence of the Nigerian Integrated Science Project (NISP). The Science Teachers Association of Nigeria (STAN), which spear-headed the science education curriculum reforms in Nigeria, of which the NISP is one, developed the first version of integrated science curriculum for the first two years of the secondary school education in Nigeria. The NISP was concerned with the teaching of science through inquiry and discovery approach in which the students come to understand and develop science concepts by investigating and experimenting on their own.

This effort by the Science Teachers Association of Nigeria in integrated science assumed a national significance in the '80s when, with the introduction of the new age phases in the education system (6-3-3-4 system), the Federal Government produced a national core curriculum in integrated science. In accordance with the National Policy on Education (1981), which stipulates that science should be one of the core subjects taught in the three-year junior secondary school (JSS) education, the core curriculum in integrated science is presently being implemented as the compulsory core science subject in the JSS (ages 12-14) in Nigeria. The integrated science core curriculum was, among other objectives, introduced with the aim of laying an adequate science foundation in pupils. This is hoped to enhance and encourage their choice of further studies of specialized science subjects and science related careers.

Trends in integrated science teaching in Nigeria
Despite the well-defined objectives that underscored the introduction of integrated science into the school curriculum in Nigeria, such process was not accompanied by any specifically well-defined teacher education program to support its effective implementation. Even after about a decade of introducing the new curriculum into the classroom, apart from the simple methodological attention given pedagogical courses of science education to undergraduate students, there was no traces of appropriate and specific certificate courses for integrated science teaching in teacher training institutions (Jegede, 1981). Teachers with qualification in single science subjects and/or some elementary science background constituted the support for its teaching.
Further research studies carried out to evaluate the progress and influences of integrated science in school pupils such as their attitudes towards the subject, cognitive achievement and their choice of science and science-related careers, were carried out by a number of science educators (Odubunmi, 1981; Mani, 1981; Bajah, 1982; Olarinoye, 1983; Akinmade, 1988; Jegede, 1983; Maduabum, 1990). The results revealed, among other things, that pupils taught integrated science were not performing up to standards. This is to say that the objectives of the course were not being attained. In respect of the pupils choice of careers, evidences abound that students’ enrollment in science and science-related careers were still on the decline (Ajakaiye, 1989). A number of factors such as the lack of or poor infrastructural facilities (laboratory building and equipment), low readability of the curriculum materials, scarcity of well-qualified teachers were listed as principal contributors to this unsatisfactory condition. On the performances of integrated science teachers in particular, Maduabum (1990) observed “much of what passes for integrated science teaching at our Junior Secondary Schools today is far from being satisfactory thereby raising serious doubt about the accomplishment of the objective of the programme.” In terms of adequate number of qualified integrated science teachers teaching the subject in the classroom today, Maduabum (1990), Nkpa, (1991), Ikeobi, (1991) observed that a majority are not qualified and competent. Maduabum particularly described the whole lot of the integrated science teaching force in the words of Coombs (1968) as “enough willing warm bodies to keep order in the classroom.”

The teacher factor pointing to the dearth of relevantly trained teachers of integrated science has become a major concern in the attempt to correct the imbalance.

**Teacher Training**

To meet the challenge of teacher education and relieve the acute shortage of teachers for integrated science teaching in Nigeria, some universities and colleges of education began to introduce preservice teacher education courses in integrated science by the mid- and late 1980s. These initial efforts by some colleges and universities were as a response to their own internally identified needs. The teacher training curricula, therefore, were as diverse as the number of institutions offering the training. However, the training curricula in the colleges of education were largely influenced or exclusively reflecting those of their universities of affiliation who were responsible for moderating their academic standards and certification.

Since the late 1980s, the number of universities in Nigeria introducing degree and other forms of certificate courses in integrated science teacher education have been on the increase. These trainings cover preservice, inservice and further training for integrated science teaching. Furthermore, the National Commission for Colleges of Education (NCCE) has, by 1992, introduced into all colleges of education in the country a national core curriculum for integrated science preservice teacher training. The implementation of this new core curriculum comes under a project: “The Nigerian Integrated Science Teacher Education Project” (NISTEP). The Nigerian Integrated Science Teacher Education Project was, until 1992, exclusively based in Ahmadu Bello University, Zaria and her affiliated colleges of education spread within the Northern part of the country. This university and three of her affiliated colleges were among the sample institutions for this research.

**Purpose Of Research**

The purpose of the research described here is to survey preservice teacher education for integrated science in Nigeria, with the aim of establishing its characteristics, quality and appropriateness of the training in fitting the teachers to their job. There is no evidence in the science education literature of studies which examine the substance of integrated science preservice teacher education in Nigeria. Rather most of the studies focused on teacher qualification and competence, readability of pupils’ and teachers’ text materials, teachers’ interpretation of the curriculum, pupils’ cognitive and affective achievement, laboratory facilities, classroom teachers’ perceptions and classroom interaction patterns (Jegede, 1981; Bajah, 1982; Bomide, 1983; Onocha & Okpala, 1990; Maduabum 1990; Nkpa, 1991).

This study specifically sought to determine: (a) the efforts and characteristic features of the preservice teacher training; (b) the relevance and usefulness of the teacher education program for integrated science students for their role in schools, bearing in mind the background of the students entering the program; (c) the concepts of integration implied and reflected in both the junior secondary school national core curriculum for integrated science and in the curriculum for preservice teacher education; further to compare and contrast the views found; (d) the perception of “integration of science” in schools held by practicing integrated science teachers, student teachers and the teacher trainers; and (e) to compare and contrast their views, particularly in areas of agreement and areas of discord.
Method, Instrumentation and Data Analysis

It was decided to study the integrated science teacher training program in two universities and those of their affiliate colleges of education. By means of questionnaires and interviews with staff and students in the two universities and their six affiliate colleges of education, data have been collected from the respondents in these institutions. Four categories of respondents-Integrated Science Course Coordinators; Teacher Trainers and Student Teachers (all from the sampled teacher training institutions) and Practicing Classroom Teachers of integrated science (from the secondary schools), responded to the questionnaires and interviews.

The questionnaires and interviews were administered personally and sought such information as: the respondent’s background and general information, the teaching of integrated science in schools, the substance of the preservice teacher training, perception of the meaning of integration in science and relevant issues for integrated science teacher education in Nigeria.

The field work was undertaken in Nigeria for a period of six months and data was obtained from a total of 263 respondents. The data is presently being analyzed and details would follow in subsequent publications. However, further inquiry in respect of this research can be directed to the London address above.

References


* S. N. Wuyep is a member of staff of the University of Jos, Nigeria, currently on a research study under the auspices of the Association of Commonwealth Universities. He is attached to the Science Education Department of the Institute of Education, London University.

Editor Note: A follow-up article or reference to findings will appear in the March 1996 issue.
A CHILEAN APPROACH TO PREPARING SECONDARY SCHOOL SCIENCE TEACHERS

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The Universidad Metropolitana de Ciencias de la Educacion (UMCE) in Santiago together with the Universidad de Ciencias de la Educacion Playa Ancha (UPLACED) in Valparaiso are the two major institutes preparing Chilean science teachers. Until rather recently, both had prepared science teachers in a fairly traditional manner, but since 1989 the Metropolitan University of Educational Sciences has embarked upon a new program to license science teachers and award them a Teachers’ Diploma. The following is a brief description of that program:

The UMCE program, devised after examining many national and international teacher preparation programs, involves students in three major areas:

1. General Pedagogy, which embraces about 30% of the total teacher education curriculum. This area includes Fundamentals of Education up to the theories and methods of science education.

2. Subject Matter (Biology, Chemistry, Physics, or the Natural Sciences), taking 60% of the overall schedule and intended to provide future secondary teachers with basic and updated principles in their major discipline.

3. A specialized Pedagogical Area combining General pedagogy with Subject Matter. This portion includes Technological Didactics, Teaching Methodology, and Educational Research.

This portion of the program lasts eight semesters (four years) and leads to the Licenciatura degree. Table 1 shows the required courses for the eight semester program.

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Table 1: Required Courses for Metropolitan University Science Education Licenciatura Degree (Eight Semesters)

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<thead>
<tr>
<th>Semester</th>
<th>Course</th>
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<tbody>
<tr>
<td>1st</td>
<td>Fundamentals of Education</td>
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<tr>
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<td>History of Education</td>
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<td>2nd</td>
<td>General Psychology</td>
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<td>Developmental Psychology</td>
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<td>Educational Anthropology</td>
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<td>4th</td>
<td>Educational Psychology II</td>
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<td></td>
<td>Curriculum</td>
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<td>5th</td>
<td>Philosophy of Education</td>
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<td></td>
<td>Curriculum II</td>
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<tr>
<td></td>
<td>Psychology of Learning</td>
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<tr>
<td>6th</td>
<td>Planning</td>
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<td></td>
<td>Evaluation</td>
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<tr>
<td></td>
<td>Technological Didactics I</td>
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<tr>
<td>7th</td>
<td>Educational Theories</td>
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<td></td>
<td>Educational Statistics</td>
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<tr>
<td></td>
<td>Technological Didactics II</td>
</tr>
<tr>
<td>8th</td>
<td>Educational Administration</td>
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<td></td>
<td>Vocational Guidance</td>
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<td>Educational Research</td>
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<td>Practice Semester</td>
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After completing the Licenciatura degree, students continue at the University to obtain a Teacher’s Diploma. This one to two-year program involves practical experience and the writing of a thesis or dissertation. Table 2 shows a typical 9th and 10th semester sequence. The writing of a thesis or dissertation usually extends beyond the 10th semester.

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Table 2: Requirements for the Teachers’ Diploma from the Metropolitan University of Science Education

<table>
<thead>
<tr>
<th>Semester</th>
<th>Requirement</th>
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<tbody>
<tr>
<td>9th</td>
<td>Supervised Student Teaching</td>
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<tr>
<td>10th</td>
<td>Supervised Student Teaching</td>
</tr>
<tr>
<td></td>
<td>Thesis or Dissertation</td>
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OUT OF THE PAST
What concerns me is not the way things are, but rather the way people think things are.
—Epictetus

16

Science Education International, Vol. 5, No. 4 December 1994
Advantages of the Metropolitan Preservice Program

The metropolitan program for preparing science teachers provides preservice teachers with courses and skills that are sometimes missing from other programs. One key component is the 7th semester Educational Statistics course. This course introduces students to the value of using educational statistics in doing educational research. The course is followed by a seminar in educational research. This course builds upon the statistics course and students are exposed to the reading of science literature and the application of this knowledge to their own scientific research. The Metropolitan University plan is certainly worth considering as one alternative to preparing more effective science teachers.

LOOKING FOR ACADEMICALLY SUPERIOR INTERNATIONAL STUDENTS

The National Youth Leadership Forum on Medicine, a nonprofit educational organization founded to help better prepare secondary school students for their future professional careers, is planning eight intensive eleven-day programs to be conducted in Boston, MA, Houston, TX, San Francisco, CA, and Washington, DC during the summer of 1995 for students who demonstrate an interest in medicine. This is the first time that international students have been invited. The goals of the forum are threefold: to educate, to inspire and to motivate.

As one of the 1994 students said, "The conference made me want to be a doctor even more. It's wonderful to be able to change people's lives for the better. I've learned that being a good doctor is not something you learn from books but by caring and knowing about your patients."

The National Youth Leadership Forum on medicine is conducted in close cooperation with internationally recognized physicians and health care professionals from some of the United State's most prestigious and technologically advanced hospitals, research facilities, and medical schools.

Criteria for Admission

In addition to academic achievement and a special interest in medicine as a career, candidates must be outstanding high school juniors and seniors who are highly motivated and demonstrate leadership qualities.

The comprehensive conference fee of $1,465 covers accommodations, breakfasts and dinners, instruction and supervisory personnel, program materials, all Forum activities and local transportation during the Forum. Transportation to and from the city in which the Forum will be conducted is not included. Financial aid information is available.

For more information and applications contact:

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Research on Curriculum, Teaching, and Learning

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Valuable insights on curriculum, teaching and learning may be gained from research and it is the aim of this section to bring significant research information to the attention of science teachers, with a view of helping them in their important work.

HOW TO CHANGE TELLERS TO TILLERS: NEEDED RESEARCH IN SCIENCE TEACHER EDUCATION IN AN ERA OF MAJOR REFORM

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Challenge to Reform

Science education is once again in the throes of a major reform effort. Project 2061 (Rutherford & Ahlgren, 1989) and ICASE 2000+ (Holbrook, 1993 & 1994) are two of the better known current reform efforts. The goal of both of these projects is science literacy. But the most recognized aspect of these projects is captured in the expression, “less is more.” In its simplest translation, less is more (LIM) promotes the practice of spending the same time on fewer science ideas. If it hasn’t already done so, LIM will probably soon replace “hands-on” as the expression most uttered by teachers at science teacher conventions.

Still relatively unknown by teachers but moving up quickly in the catch-phrase ratings is the term “constructivism” (including all its word forms). The idea that students construct their own meaning for ideas using previously held notions as filter, foundation and mortar is also being promoted heavily in Project 2061, ICASE 2000+, and the general reform literature.

Obstacles to Reform

The LIM theme and constructivist seem friendly enough in principle, but their translation into practice is fraught with obstacles. For instance, there is the chance that the LIM theme could be taken as license to move traditional science courses in biology, earth science, etc. into lower and lower grade levels (a practice already evident in the “middle school” movement). Constructivism could also be misinterpreted to mean or support “hands-off, laissez faire” teaching where students are simply set free to explore and discover on their own, reminiscent of the discovery learning/inquiry teaching in the post-Sputnik reform years.

Initially teachers and teacher educators will probably simply dismiss reform ideas as new fads. After it is realized that the LIM theme is more than cutting a topic or two from a syllabus and that constructivist teaching is much more demanding than saying “what do you think?” a period of denial may set in, characterized by teachers saying, “these reform ideas don’t apply to me, I am already doing LIM” and/or “I am already a constructivist teacher.”

Once the initial stages of dismissal and denial pass, there will be a need for research on the LIM theme and constructivist teaching strategies. From a science teaching perspective, a major implication of the reform ideas of Project 2061 is the need for teachers to shift from the role of “teller” (disseminator of knowledge) to the role of “tiller” (cultivator of student minds) in the classroom. But the teller paradigm is well established with teachers, students and parents. Assuming that constructivist principles apply to any group challenged with new ideas, convincing students, teachers and parents of the logic and effectiveness of “tilling” strategies will take time and challenge the best tilling strategies of the teacher education community (Hand, 1993; Shymansky, 1992).
Needed Research

Science teacher education research will best serve the teaching community by addressing questions of how telling and tilling roles compare and contrast; how variations in tilling strategies impact student learning; and what models of teacher preservice and inservice are most effective in turning out tilling teachers. Indeed many classroom teachers are searching for guidance on how to restructure their science curriculum and revise their teaching strategies. Teacher educators are busy trying out new models of teacher inservice based on reform documents, perhaps more important than the research and development of inservice models however, will be the work done to restructure the science courses and the professional education programs of preservice science teachers. Research at the preservice level has the potential for facilitating reform that will carry science education to the year 2000 and beyond.

References


PHYSICS TEACHING (ENGLISH EDITION)

Physics Teaching is a magazine of intermediate academic level published by the Chinese Physical Society. It was first published in 1978 and more than 150 issues have been published up till now. The major target readers of the magazine are secondary school physics teachers, with also college physics teachers and students in mind. Major contents include advances in physics, studies in pedagogy and teaching materials, development in equipment and experimental design, physics and its daily relevance, etc. At present, the circulation of the magazine is around 40,000.

In order to strengthen the tie with readers outside China, the Editorial Board and the Hong Kong Association for Science and Mathematics Education (HKASME) decide that beginning from 1994, an English edition of Physics Teaching will be published. The English edition will be published annually with translation of selected articles from the Chinese edition.

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STUDENT SELF EVALUATION: THE LEARNING PROCESS

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Abstract
Many students have not thought about how they learn and about what types of studying activities are most profitable for them. One way of getting them to seriously consider their own learning process is to have them assume part of the responsibility for monitoring and evaluating the quality of their own work. The mechanism chosen to accomplish this was to have the students in an Organic Chemistry course maintain a portfolio in much the same way that art students do. The students were instructed to include items in four categories: (a) description of steps taken, (b) descriptive material on learning practice, (c) products of learning, and (d) self evaluation. Thus, they had a chance to select, prepare, and explain items that they felt accurately represent their actual performance. This activity is successful not only in causing a greater reflection by the students on the learning process, but also fosters greater interaction between student and professor and between students.

Introduction
Recent literature speaks of “the scholarship of teaching” and points out that the teaching portfolio has promise as a tool for assessing such scholarship (Edgerton et al., 1991). Portfolios can also be used to assess student performance in science courses (Barrow, 1993).

Over the years, I have taught organic chemistry courses in Chile, Brazil, and the United States. I have often observed that part of the difficulty that students have with organic chemistry is due to poor study habits, unrealistic ideas of what is expected of them, and unwillingness to do the hard work necessary to understand the concepts of organic chemistry. Many students do not improve as the semester progresses because they do not think about why they do poorly. They do not evaluate their own performance versus courses expectations.

In order to stimulate such self-evaluation, I decided to have the students maintain a portfolio. At present this activity is optional, and students elect to do a portfolio, they may substitute the portfolio grade for one of the exam grades (three exams are given during the semester and a final at the end of the semester). The majority of the students choose to keep a portfolio.

Theoretical Basis
Constructivism is the theoretical basis for using the portfolio as an assessment tool. This is learning by constructing meaning out of the student’s own experiences. The ability of students to answer questions related to a limited number of situations can be tested by exams. However, the constructivist teacher must also be able to examine the student’s performance in other ways. Competence cannot be determined on the basis of one performance but rather on the basis of continued and varied performances (Wiggins, 1989). The portfolio gives the instructor a way of assessing non-traditional performance of each student. It also gives students a chance to choose what they think should be included in the assessment.

Method
The first questions students ask are, “What is a portfolio? What do I put into a portfolio?” In order to answer these questions, they receive a document which defines portfolio, gives reasons for using portfolios in the course, and indicates possible and required items to be included in the portfolio. (See Appendix A.) Approximately one week after receiving this information, students communicate
their decision to the instructor by signing a “contract” form (see Table 1). Once students make their decision, they are responsible to abide by that decision.

In order to insure that students work in a continual manner on their portfolios, some assignments must be handed in during the course of the semester. These are not graded, but points are given for each one. Also, the students may be requested to turn in their portfolios at any time during the semester so that the ongoing nature of their work may be verified.

The documents that students turn in during the semester include:
1. an objective statement in which students state what they hope to accomplish with the portfolio and how they plan to accomplish these goals;
2. a mid-term progress report in which students explain what they have done up to that date;
3. a self-evaluation, written immediately after taking each exam, in which students evaluate their performance and tell whether their study methods were effective in preparing for the exam;
   a. If not, why?
   b. How would they change them?
   In addition, the students comment on the exam itself:
   a. Did the questions match the material?
   b. Were the questions clear or ambiguous?
   Their perception of the exam length.
4. an evaluation, written after receiving the graded exam, in which the student states whether the previous self-evaluation was accurate. If it was not, the student is asked to determine what led them to overestimate or to underestimate their performance. Students may also comment on the grading of the exams; and
5. a final report, turned in at the end of the semester, in which students assess their overall performance and learning during the whole semester.

Results

This method was used in one section of Organic Chemistry II during Spring semester of 1994 and is currently being used in one section of Organic Chemistry I. The results, therefore, are not complete, and so this is, in reality, a preliminary communication of ongoing work.

The idea of the portfolio was introduced in the syllabus and discussed briefly during the first class of the semester. The document explaining portfolios was distributed to the students by the third class, and the contracts were signed by the students at the end of the second week of classes. During Spring semester 48 of the 56 students opted to do the portfolio (Fall semester: 49 out of 63).

The objective statements were handed in at the beginning of the third week of classes. A wide variety of goals were mentioned in these
1. to obtain a grade of A (B or C, depending on the student);
2. to improve study techniques;
3. to improve time management skills;
4. to gain insight into how one learns;
5. to keep from procrastinating;
6. to be able to use it as a tool in the future;
7. to find out how organic chemistry relates to their major or to everyday life;
8. to show the instructor how much work was put into learning;
9. to investigate the role of organic chemistry in history; and
10. to understand organic chemistry better.

Other ways cited to help accomplish goals included: keeping journals, forming study groups, doing extra problems, making study tools (flash cards, charts, etc.), teaching fellow students, reading current literature, recopying notes, writing summaries, asking questions more frequently, and interviewing other persons.

The portfolios were collected on the day of the final exam. The evaluation was based on the required documents that had previously been collected (maximum 60 points), on the quality of the content of the portfolio, and on fulfillment of activities in the student’s original, or revised, objectives statement.

Conclusions

The use of a portfolio in Organic Chemistry has been very well received by the students. Many felt that it should be a required part of the course rather than being optional. One student even complained on the student evaluation forms that it was unfair that they had not been required to do a portfolio.

Does a portfolio improve student performance? Almost every student said that their performance was improved by working on a portfolio. Quite a few indicated that they intended to use this method in other courses. With such a small sample, it is really difficult to determine if the portfolio improved performance. However, the portfolio grade was similar, in most cases, to the average grade that the student had obtained on the exams. Only one student who did a portfolio obtained a grade of D; none of them failed the course, whereas the failure rate was much higher among students who did not do the portfolios. This may be due to the fact that students
who did not want to spend time on portfolios also did
not spend much time studying.

About a third of the students who did portfolios commented that they were repeating the course and that, at least in their opinion, the portfolio was responsible for keeping them focused and enabling them to understand Organic Chemistry. The top three grades in the course were obtained by these repeaters. Others obtained grades of B and C.

Portfolio students felt that they had more control over their own learning, spent more time thinking and discussing how they learn and deciding whether their methods were effective. The portfolio also provided them with opportunities to discuss their activities and ideas with other students (as evidenced by their journal entries) and with the professor. In this sense the portfolios seemed to foster a greater sense of community.

In summary, portfolios hold promise as a method to give students more input as to what they feel is important for their own learning and intellectual development. They, also, help the student become an active participant by making them aware of the fact that passive learning is not possible.

References


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Table 1

This is to verify that I, ____________________________, have received a copy of the syllabus and have read it. I choose to follow the option marked below:

A. Three hour exams + Final Exam, only ____

B. Three hour exams + Final Exam + Portfolio, which will replace the lowest grade on the hourly exams ____

Signature (please sign in ink) ____________________________

Date ____________________________

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APPENDICES

Appendix A

**Student Handout on Portfolios**

**DEFINITION:** A portfolio contains evidence of the student’s strengths and learning achievements. It reflects the knowledge obtained in a course, skills that have been developed, ideas and reflections about the learning process, and comments concerning applications to the student’s major field of study and to their lives. A portfolio can be used for varying purposes. In this course the portfolio will be used to show student progress in ways that cannot be evaluated by exams. In turn, it will be used by the professor as an aid in assessing student performance in organic chemistry.

**General Information**

The portfolio:

1. must be related in some way to organic chemistry.

2. must have a purpose or objective statement concerning what the student wishes to accomplish and how they propose to attain stated goals. A copy of this statement should be turned in to the instructor by the end of the third week. A second copy of the statement should be placed in the portfolio.

3. must contain a mid-term progress report (due at the end of mid-term week) and self-evaluation (one after taking each exam and one after receiving the graded exam) during and at the end of the semester. Copies of these should be turned into the professor and a second copy placed in the portfolio.

4. should be a *selective account* that highlights what is unique to each person; including, approach to learning and relating course subject matter to things that they find interesting.

**Reasons for Using Portfolios in This Course**

1. Learning is a complex and individual process. Each student has their own way to approach learning. A portfolio permits documentation of the process on
an individual basis.

2. The portfolio involves each student in evaluating their learning progress. It places part of the responsibility for monitoring and evaluating the quality of one's own work in the hands of each student, giving them a chance to select, prepare, and explain entries that they feel accurately represent their actual performance. In that sense, it gives each student an opportunity to set their own standards for effective learning.

3. Hopefully, the portfolio will prompt a greater reflection on the learning process and on how to improve it.

4. Discussion of portfolios among students is also hoped to stimulate cooperative work and open communication.

Possible Items for Inclusion

A. Description of Steps Taken:
   A journal which contains a record of:
   1. daily or weekly efforts made and time spent;
   2. outside reading of articles;
   3. exchange of information and material with peers and others;
   4. attempts to try “new” methods (film, computer, etc.) and to evaluate effectiveness;
   5. participation in study groups and/or discussion groups;
   6. preparation of study materials and of reports;
   7. conferences with professor, tutors and/or others;
   8. steps taken to emphasize the interconnectedness of organic chemistry and other areas.

B. Descriptive Material on Learning Practice
   1. copies of problems solved independently or with groups;
   2. explanations of choice of problems and/or methods;
   3. written decisions of ideas;
   4. written critiques of articles;
   5. reports on group activities;
   6. self-reflective essays;
   7. examples of study materials that were prepared (flash cards, outlines, student-made tests or exercises, etc.)
   8. identification of individual strong points and/or weak points.

C. Products of Learning Practice
   1. copies of graded exams, quizzes and exercises
   2. self-evaluation reports (evaluations by peers and others may also be included);
   3. mid-term progress report;
   4. final progress report;
   5. copies of graded work done in other classes that demonstrate the student’s ability to use organic chemistry in another field.

Other items that the student thinks may be appropriate may also be included. It will be helpful if students indicate the reason for including them.

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(Please quote the seminar number in all correspondence)
Karachi has often been called “a city of contrasts.” This city of between 7 and 9 million people is home to the richest and poorest in Pakistan, a developing country in South Asia. Schools in Karachi reflect this contrast. At one end of the spectrum are schools that have well-equipped computer laboratories and send almost all of their graduating students to the most prestigious colleges and universities in Pakistan or in the U.S.A. and Europe. At the other end are schools run in cordonned off areas of quieter streets, where several students share a textbook, and about a half drop out before completing grade five. In between are schools that offer a wide range of learning experiences to their students: these are schools that are owned by the government or private parties, funded by trusts or run on commercial grounds, with English or Urdu (the national language) as medium of instruction.

In 1983 a small group of heads and teachers began to meet regularly to work out some ways to bridge this gap between schools. Their mission was to share resources, information and expertise among schools; to replace the culture of isolation with cooperation between schools; and to provide a forum for the professional development of teachers. They began to make plans for setting up the Teachers' Resource Centre (TRC), with schools as institutional members, teachers and other interested people as individual members, and an elected governing body made up school representatives to oversee the work of the Centre. While members of this group were very articulate about the need for such a place and the potential functions of TRC, they did not know how to give it a legal framework and seek funds for it. The Education Officers of the Aga Khan Foundation (AKF), an international funding agency with an office in Karachi, heard about the activities of the group and encouraged them to write a grant proposal. Drawing upon the expertise of friends, acquaintances and parents of students in their schools, the group began to make a rudimentary proposal. The local British Council invited an educator with the appropriate experience to help crystallize the group’s ideas into an acceptable format for a grant proposal. The TRC was finally set up in 1986, funded by AKF for five years, during which it had to gradually reduce its financial dependence on AKF and to build up an endowment fund. At the end of this period, it operated with its own funds for one year, after which it was given another major grant by a national agency called Trust for Voluntary Organisations. Its current endowment fund is about half of the amount needed for total financial independence.

The governing body employed teachers to fill all of the professional positions at TRC. Based on their personal knowledge of what teachers need to learn and how they learn it most readily, they began to conduct and organise workshops for teachers. So, for example, in one of the early workshops teachers were helped to see connections between the official primary science curriculum document and the prescribed textbook. Before this most of the teachers had never seen a curriculum document and used the textbook as the only guide for their curriculum. In another two-week workshop, secondary science teachers were helped to construct models and design experiments using inexpensive or scrap materials. Again, for most of them this was something quite novel. They had not encountered teacher constructed models or simple experiments using everyday materials in their own learning of science in schools or in colleges. Even those who had been through a
formal teacher education\(^1\) program either did not learn to do these or had jettisoned this “scholastic knowledge” from their minds, as soon as the need for its “performance” was over (Gardner, 1991).

To bring together schools as whole units, large scale annual events were organized. The Science Exhibition was one such event. Twenty-two schools put up a collective exhibition of models and experiments, and about four thousand students and teachers, as well as a few parents visited this exhibition. Science exhibitions had been held in the city before but the hallmark of this event was the collective effort that teachers made to help display each others work and share organizational responsibilities. In the past, space was allocated and schools were asked to set up their own stalls and compete for prizes for the ‘best’ exhibits. This exhibition was organized by themes rather than by schools and no prizes were offered.

On a broader level the major achievement of TRC has been the establishment of a collegial professional forum for teachers. Almost all teachers who come for the first time to TRC, whether it is for a workshop or for specific advice, remark about the hierarchy free and caring atmosphere which helps them learn better. School teachers who are mostly women, working in a low paid, low status profession, especially appreciate this. However, not all of their professional needs can be met by TRC and they leave in frustration because no other forum is available to them.

Teachers need more and different subject matter knowledge, particularly in science and mathematics, than what they learn in college. Many of them have inadequate understanding of scientific and mathematical concepts that they are required to teach. Even when their own understanding matches what the ‘experts’ believe to be true, they are ill prepared to transform their knowledge into appropriate representations for school children (McDiarmid & Ball, 1990). The TRC is staffed mainly by primary school teachers who themselves are not well-grounded in science subjects, therefore, their capacity to help teachers in this area is limited. When they monitor workshops they are able to tell whether teachers are actively engaged or not, but it is hard for them to assess whether the participating teachers’ learning is fundamental to understanding the subject and its teaching. Workshop leaders who have more ‘expertise’ in terms of higher degrees, often use arguments and examples that are peculiar to their discipline, but not necessarily understood by teachers who do not share their background. The lack of a combination of pedagogical and subject matter expertise leads to problems which TRC has not yet been able to address. Teachers attending TRC workshops pay greater attention to and subsequently only ask for, workshops that give them “bright ideas” for teaching on Thursday afternoons, or “tips and tricks” for making next week’s lesson more interesting. Their more fundamental needs remain unaddressed, and they are often unable to extend themselves beyond what they learn at particular workshops.

Another area where TRC has not been able to give teachers as much support as they need, is in their classrooms. When teachers learn new teaching strategies they ask for workshop leaders to help them try out what they learned in their classrooms. Because the workshop leaders are most often teachers themselves, they don’t have the time to visit anyone during the school day. Even when a TRC staff member is the workshop leader it is very difficult for them to give follow-up support to teachers, because TRC’s “productivity” and thus the value of the work of its staff is counted more in terms of numbers of workshops run and teachers served. Rather than the more invisible but very time consuming work of follow-up support.

TRC leaders have recently been re-assessing what they have achieved in the last eight years and are also deliberating the future of the Centre. The sharing of ideas, information and resources among schools has continued, but it is still done ad hoc and in reaction to external stimuli rather than as a part of the school culture. Heads and teachers from different schools meet more often for professional purposes than they did before, but they do not routinely include contact with other schools in their work life. The most dramatic change that has taken place, however, is in the importance now given to teacher development by policy makers, administrators and teachers themselves. Several new initiatives for teacher development have been taken in the public and private sector. These include school based, university based and mobile short term training programs. Leaders of some of these programs have tried to keep exchanging ideas with TRC staff, while others have preferred to evolve their own models. Meanwhile, TRC has developed a niche of its own. While it does not try to be everything for everybody, keeping its egalitarian stance while maintaining high standards,

\(^1\)Many teachers in Pakistan have not gone through formal teacher education programs (editor)
reaching out to those who cannot pay for its services but also trying to become financially independent, and developing the expertise of its staff who will not sell themselves as “experts,” continue to be the challenges for the future.

References

Section Editor’s Note: In both industrial and developing countries teachers often work quite alone and isolated in their classrooms. Talks with other teachers are too frequently limited to routine matters such as test results or naughty kids. However, when motivated teachers do get together and start a process of shared professional development, miracles can happen and real pedagogical subject knowledge can develop.

This article provides a fluent description of a teacher resource centre run by teachers in Karachi, Pakistan. Actually, the description might be too fluent and not show sufficiently the difficulties faced by the author and her colleagues in establishing and running such a centre in a developing country with very low teacher salaries, rather hierarchical and bureaucratic structures, and a relatively low priority for education (compared to other developing countries). A World Bank “Pakistan: Education Sector Review” reported in 1988 a literacy rate of only 30% and identified teacher education as one of the main problems. A rather large proportion of teachers in Pakistan have not gone through formal education programs.
THE THIRD INTERNATIONAL MATHEMATICS AND SCIENCE STUDY: AN OVERVIEW

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Abstract: The objective of TIMSS is to compare the teaching and learning of mathematics and science in some 50 countries. The results of the study will assist participating countries in planning ways to enhance their curricula, teaching practices, and student achievement. In addition, the results will provide feedback to countries about how their educational systems compare to others participating in the study.

Introduction

Large-scale, cross-national research studies provide rich opportunities for increased understanding across national boundaries. Educational studies such as the Third International Mathematics and Science Study (TIMSS) offer particularly fruitful opportunities for such increased understanding, partly because of the nature of the educational enterprise, but also because of advances that have been made in our understanding of effective teaching and learning practices, measurement theory, assessment practices, and curriculum analysis.

Some people, particularly those who are not part of the educational community will be interested in a study such as TIMSS because of the current increased international focus on the relationship between education and economic prosperity, increasing global competitiveness, and sweeping political changes in many areas of the world. Governments around the world are facing similar problems of having too few dollars and too many obligations. The need to provide the most effective education system possible while containing expenditures is a powerful stimulus to find out more about what makes an education system effective.

To improve the effectiveness of an educational system requires information about what students are capable of doing. Educators in any national school system may well believe that students are challenged to their limits by the curriculum; but self-examination, that is scrutiny of the familiar, cannot produce the same information as comparative research will reveal. It is not possible to examine in a critical and productive way significant aspects of any single system from within that system, since the unquestioned will remain unexamined. In this era of increased globalization and international competition, it is vital to answer the important questions of how to improve educational practice. International comparative research studies in education provide a vehicle for such analyses.

Value of International Studies

Critics of international surveys of achievement have commented that these studies require large expenditures of time, energy, and money on the part of participants as well as the investigators. In addition, questions have been raised about the significance and the impact of the findings from such studies. Support for the value of international comparisons in education, on the other hand, has come from a variety of sources including, most recently, two publications produced by the U. S. Board on International Comparative Studies in Education (Bradburn & Gilford, 1990; Gilford, 1994).

Insofar as the practical value to be derived from participation in international studies is concerned, Husén (1967) has described how international studies use the “world as an educational laboratory.” International studies provide investigators with an opportunity to assess the importance of variables which it might be impossible to manipulate from within their own jurisdictions: for example, class size, single-sex schools, out-of-school tutoring (Eckstein, 1982). A number of countries have initiated curricular and school policy reforms based on the
basis of results from previous international studies, when a comparison of the results indicated the need for review of their national agendas (see, for example, Degenhart, 1990).

The educational system within a given country is typically rather uniform with regard to variables such as class size or age of school entry, with the result that it is not possible to manipulate those parameters to investigate the extent of their influence on variability within the system. However, by studying the influence of variables across countries, with an accompanying increase in natural variability, one can better examine the implications of alternatives. Hence, the central comparative question each country may well ask is: How do other countries educate their youth differently, and with what degree of success? Different approaches to the same goal can be compared, and their impact evaluated.

The efficacy of an educational innovation may be evaluated by examining its implementation and operation in another country. New approaches to teaching may be found by observing classroom practices of teachers from other countries. Stigler and Perry (1988) suggest that cross-cultural comparisons also lead researchers and educators to the development of a more explicit understanding of their own implicit theories about how children learn mathematics. In all probability, this principle can be generalized to other content areas, including science. Without comparisons, we tend not to question our own traditional teaching practices and we may not even be aware of the choices we have made in constructing the educational process.

International Association for the Evaluation of Educational Achievement

The International Association for the Evaluation of Educational Achievement (IEA) was established more than 30 years ago in response to growing interest in comparative education research and the need to develop standards for conducting empirical research in this emerging field. Chartered in Belgium and with a permanent secretariat in The Hague, IEA includes representation from over 40 educational systems in 35 countries around the world. IEA conducts a cycle of studies on a regular basis approximately every decade. Each of these school-subject studies is curriculum-based, issue-centered, and interdisciplinary in scope.

IEA is well positioned to conduct international studies because comparative research is its raison d’être. For over 30 years, the IEA network has been setting standards for international survey research: study design, test construction tied to international curricula, scientific sampling, data analysis, and dissemination of findings to a wide international audience of policy makers, researchers, and educators. IEA studies not only generate important univariate comparisons across individual test items and subscales, but also explore observed differences through multivariate analyses tied to a conceptual model.

In the early 1960s, the first IEA survey was conducted in 12 countries. Since then, academics, educators, administrators, policy-makers, and political representatives have looked, in increasing numbers and with increasing frequency, to the findings of IEA studies to provide a context within which to draw conclusions about the state of their educational systems. The emergence of the concept of accountability as a significant factor in determining funding levels for educational systems has undoubtedly contributed to this trend. Educational administrators and representatives of governments now, more than ever before, seek to rationalize and justify the amounts of funding needed to operate school systems at appropriate levels of service.

The organizational structure of IEA facilitates efficiency in carrying out comparative international survey research. That structure includes the General Assembly with representation from each member institute, a chairperson (currently Professor Tjeerd Plomp from the University of Twente in the Netherlands), a Standing Committee (Board of Directors), and a permanent IEA Secretariat located in The Hague. Each IEA-sponsored project has its own international coordinating center which is responsible for carrying out the study. The ICC is in its turn supported by an International Steering Committee and the IEA International Headquarters.

Results from Earlier IEA Studies

Previous IEA studies have reported on cross-national differences with regard to participation or retention rates, the extent of tracking or streaming, gender differences in achievement, the content of the curriculum, teaching practices, and many other variables of importance to the teaching-learning process. Many of the findings from these studies challenge the conventional wisdom which underlies educational practice, and they demonstrate that radically different approaches to the teaching and learning of mathematics and science are not only viable, but demonstrably successful.

A number of important variables have been identified in international studies over the past 25 years. Course content, or opportunity to learn, has been shown to be an important variable in accounting for differences in achievement among students from
different countries. But opportunity to learn also provides information on what is possible for students at a given age or grade level to learn.

International studies have shown that educational systems can retain very large proportions of the age cohort in the study of academic mathematics or science at the senior secondary level without penalizing the best students. Secondary analyses of the data from the first and second IEA studies in mathematics and science indicate that the highest ability students from almost all systems performed at about the same level on topics which they all had studied. The major differences among the best students appeared to be mainly a function of opportunity to learn.

Previous IEA studies of mathematics and science have produced valuable insights into a number of aspects of the teaching and learning process. In addition, they have provided a number of important lessons with respect to the design and conduct of large-scale international research projects in education. TIMSS has built on this foundation, and it will provide further information about a number of important matters such as:

- current national and international data which countries can use to compare and contrast their curricula, teaching practices, and student outcomes with those from other countries of interest.
- an assessment of the potential impact that alternative curricular offerings, teaching strategies, and administrative arrangements have on learning.
- an identification of what is possible in the teaching of mathematics. For example, results from SIMS showed that extremely high growth rates were evident in Japan and France. That finding indicates that more significant growth rates might be possible in other countries, and that we must strive to identify the underlying causes of those high growth rates.
- a greater understanding of how and why student attitudes change, and what relationship the development of positive attitudes bears to classroom practices. Such an understanding is crucial to the development of a more complete picture of how mathematics learning takes place.

Earlier IEA studies have provided glimpses of the nature of teaching and learning in mathematics and science. In addition, they have laid foundations on which to build a deeper understanding of what takes place in the teaching and learning process.

**Research Design for TIMSS**

TIMSS is the largest and most comprehensive study of educational practices in mathematics and science ever undertaken. The goal of this study is to examine the teaching and learning of science and mathematics for students at three levels: the pair of grades containing almost all 9-year-olds (Population 1), the pair of grades containing almost all 13-year-olds (Population 2), and the final year of secondary school (Population 3). Students will provide information about their attitudes toward science and mathematics, their family and school circumstances as well as completing an achievement survey. In addition to student data, information about teachers, schools, and administrative structures, as well as national or system-level information will also be collected.

The study will be of interest to a wide range of audiences including parents, academics, educators, policy-makers, researchers and politicians. The groups will have varying perspectives and interests in the results. These will certainly include:

- educational policy-makers who wish to investigate possible linkages between indicators of school performance and economic strength in order to develop or modify educational policy;
- educational researchers who wish to employ improved measures of educational performance, along with a variety of other educational indicators, to further their research goals;
- curriculum specialists in mathematics and science who wish to improve their understanding of the nature of the relationship between curriculum and student outcomes;
- teachers of mathematics and science who wish to increase their knowledge of effective instructional practices;
- the public who place high expectations on the educational system of their country.

Over 50 countries are intending to participate in TIMSS, and they are listed below. The list of participants includes representatives from all geographic areas and all levels of economic growth, although some parts of the world—such as Africa, the Indian subcontinent, and South America—are under-represented. Such broad participation indicates the widespread interest that exists in understanding

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**FOOD FOR THOUGHT**

A grade is an inadequate report of an inaccurate judgement by a biased and variable judge of the extent to which a student has attained an undefined level of mastery of an unknown proportion of an indefinite amount of material. —Dressel, P. (1957, Winter). Definition of a grade. Basic College Quarterly, 6. Michigan State University.

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Science Education International, Vol. 5, No. 4 December 1994
the kinds of activities that can be successful in education, so that each country can address itself to appropriate national reform.

Argentina     Ireland
Australia     Israel
Austria        Italy
Belgium (Flemish)    Japan
Belgium (French)    Korea
Bulgaria        Kuwait
Canada         Latvia
Chile          Lithuania
China          Mexico
Chinese Taipei  Netherlands
Colombia       New Zealand
Costa Rica      Norway
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Denmark         Russia
Dominican Republic Ecuador        Singapore
England         Slovak Republic
Estonia         Slovenia
France          South Africa
Germany         Spain
Greek           Sweden
Hong Kong       Switzerland
Hungary         Thailand
Iceland         Tunisia
Indonesia       Ukraine
Iran            United States of America

\^aParticipation uncertain.

The study is operating on a tight timeline with several major activities scheduled for 1994. Some of these involve the piloting of achievement items and questionnaires. There have already been a number of activities in the collection of national-level \^lata, and analysis of curriculum.

January - April 1994
  Field trial for Population 3 booklets
March - May 1994
  Field trial of Populations 1 and 2 booklets
September - November 1994
  Main data collection in southern hemisphere
March - May 1995
  Main data collection in northern hemisphere
June 1996
  Publication of first international report

An important facet of educational research is obtaining an understanding of the context in which the educational event of interest occurs. This is an even more important component of cross-national comparative research, when it is evident that significant aspects of a nation's culture can exert powerful influences on the educational system. An example of these contextual factors is the level of societal expectation with respect to education. What are the views of the society about the nature of education, the status accorded to educators, family and community support for school activities, accessibility to post-secondary education, or the view of society with regard to lifelong learning?

Obtaining this kind of information is difficult. There are problems of sampling, costs, and perhaps a lack of motivation on the part of respondents: Who wishes to participate in yet another survey? There is a further problem of how to match what people may say in a general way about education, with a useful critique of curriculum.

One approach that has been taken in TIMSS to understanding some of these context variables is a comprehensive curriculum analysis, since what is in the curriculum can be assumed to reflect, to a reasonable extent, what is valued by the society. Curricular reforms generally take place following broad consultation with various sectors of society. In this way, the curriculum can be viewed as a proxy for what is deemed to be important by a society in preparing young people for their future. In TIMSS, efforts to understand some of the differences in student achievement will be based on an examination of science and mathematics curricula more intensively than has been done in previous studies.

**Curriculum Analysis**

There are three kinds of curriculum that are the focus of various activities in TIMSS. The broad view of curriculum in science and mathematics is being examined to provide information about the specific topics that are important to mathematics and science educators, and constitute a significant part of the curriculum in nations participating in the study. This has served as the basis for the development of the achievement survey. Second, particular topics are being reviewed in detail to provide data about curricular organization and approach not only at the age levels selected, but throughout the full span of grades. Finally, curriculum experts in each country have been asked to review developments in the past five to ten years, the effect of reforms, and curriculum changes forecast for the next five years. While no individual can foretell the future, the time required for design, development and implementation of curriculum changes places those knowledgeable about curriculum developments within a country in a better position than others to make such forecasts.

TIMSS will explore the intended, the implemented and the attained curriculum in a
variety of ways. The conceptual relationships among these three versions of the curriculum and their contexts are displayed in Figure 1.

Figure 1. Conceptual Framework for TIMSS

The intended curriculum consists of the mathematics and science content as defined at the system level. The locus of decision-making in this regard varies. In some countries, authority may be placed in the hands of many small, local jurisdictions; in others there may be a highly regulated central authority for a large jurisdiction. Nonetheless, the intended curriculum is embodied in textbooks, in curriculum guides, in the content of examinations and in policies, regulations, and other official statements generated to direct the educational system. The intended curriculum, the mathematics and science content which students are expected to study and learn, may be described in the form of mathematics and science concepts, processes, skills, and attitudes.

The intended curriculum is set within an educational context that includes institutional arrangements for the system. Educational decisions made at the system level include such features as decision-making structures, school organizational patterns, teaching assignments, and fiscal and human resource inputs.

The intended curriculum, the perspective from the system level, is situated within the larger context of society. The societal context includes those variables which influence system-level institutional arrangements and curriculum content. Illustrative aspects of this context are: the goals, expectations, and values society holds for schooling; overall participation rates; the role of private schooling; the expectations held and the arrangements made for professional preparation of teachers; the professional status accorded to teachers in society; as well as the resources society has and the proportion of those allocated to education.

The implemented curriculum is the mathematics and science content as it is interpreted by teachers and made available to students. Previous research has shown that the implemented curriculum, even in highly regulated educational systems, is not identical to the intended curriculum. However, the implemented curriculum is influenced by the intended curriculum, and it can be described in terms of concepts, processes, skills, and attitudes.

The implemented curriculum is set in an educational context that consists of institutional arrangements made at the school and classroom level. These are influenced by and, to some extent, dependent upon the system-level arrangements. This level of institutional arrangements differs from the system-level arrangements in that the locus for decisions is at the school or classroom level. These are comprised of such things as teaching practices, aspects of classroom management, use of resources, teacher background, and so on.

The implemented curriculum, the perspective from the level of the school and classroom, is situated in the context of the local community. In some cases, this is a mirror image of society-at-large, and the same features are important. In other cases, however, local communities within an educational jurisdiction vary a great deal. Illustrative features of this context are the socioeconomic status of the community, expectations held for schooling, and the participation rates of students and parents in the community.

The attained curriculum consists of the outcomes of schooling: the content of mathematics and science students have learned in the course of their studies. What students learn will be influenced by what was intended and by the opportunities that were made available to them. The attained curriculum can be described in terms of the concepts, processes, skills, and attitudes in mathematics and science.

The attained curriculum is set in the educational context of the individual student, and it consists of the institutional arrangements the student makes or has made for his or her own learning: the amount of homework the student does, the effort the student expends, the student's classroom behavior patterns, and so on. While these factors are greatly influenced by both the system and classroom level arrangements, they differ in that the individual student has some direct control over these arrangements.

The attained curriculum is situated in the context of the student's personal background, and is likely to reflect the society and community contexts.
However, the student’s personal context is not likely to be exactly the same as those other contexts. Thus, it is important to add this additional sphere of influence in order to obtain a comprehensive view. Illustrative of these features are the attitudes about education that the student brings to school, aspirations, perceptions of ability to succeed, parental expectations for student’s success, and economic well-being of the student’s family.

The boundaries between the content, the institutional arrangements, and the societal context are not always distinct. Nor is it important that they be clearly delineated. The important point is that the variables of three different kinds of curriculum must be considered in light of three different levels of institutional arrangements, within three different societal contexts. Together, the content and institutional arrangements of the intended, implemented, and attained curricula, and features of the society-at-large, the local community, and the student’s personal context comprise an appropriate description of the educational environment.

**The Importance of TIMSS for Teachers and Curriculum Developers**

In the Second International Mathematics Study comparisons were made of mathematics curricula, of teaching practices employed in the teaching of specific topics such as integers or rational numbers, and of streaming or tracking of students. Similar research components can be found in the Second International Science Study. Such studies provided a view of what can be accomplished, a context in which decision makers in each participating country can view their own system.

In the development of TIMSS there has been a concerted effort to identify the relationships among the components of the educational system: policy, administration, teachers, and students more clearly. At the teacher level, a synthesis of the research provided by Porter and Brophy (1988) outlines four areas of influence on teachers’ instructional practice that focus the research questions: teachers’ personal experience and professional education; teachers’ development of classroom routines; teachers’ planning; and teachers’ knowledge and convictions regarding content, pedagogy, and student needs.

There is also a commitment to the reporting of the information from the study in ways that are useful to practitioners. The goals set for the reports published by TIMSS include:

- to provide descriptions of the learning and teaching of mathematics and science in classroom contexts.
- to ensure that such portrayals are valid, reliable, and meaningful for educators to read.
- to provide science and mathematics educators with descriptions and results that they can use to improve their own teaching practices and classroom environment.
- to provide curriculum planners and policy-makers with decision-making data grounded in the lives of those most affected by such decisions.

The information provided in the tables in Appendix C is preliminary, and presented to show the differences in content and instructional intention as found in the document analysis part of the curriculum study. Not only are there striking differences between content, particularly at the Population 2 level, it is clear from the description of student expectations that curriculum developers and textbook authors reflect very different intentions in the programs that are designed to meet a country’s needs. The more interesting information will be the investigation of the relationships between curriculum as intended, as implemented and as attained—what the students actually know and can do. The premise is that for increased effectiveness of an educational system it is not sufficient merely to know what does not work. It is essential to know what works, and what students in other nations can do, as revealed by the intended curriculum and their achievement. For teachers this is also important information for their own professional growth.

The ways in which teachers in other countries provide instruction on particular topics can also be of direct relevance to teachers. TIMSS will not only provide information about the range of approaches that teachers throughout the world may find to be effective, it may also provide some reassurance that certain topics are not easy for students to grasp in any educational system. In the second mathematics study, for example, all students had difficulty with the algebra items, in spite of a wide range of instructional approaches reported.

**Current Status of the Study**

One of the major objectives for the study in 1994 is to finalize the development of the instrumentation for the investigation of the implemented curriculum and the attained curriculum. This includes the achievement survey instruments, as well as the questionnaires to be administered to students, teachers, and school principals. All of the instruments need to be provided to participating countries with sufficient lead time for them to be translated where necessary.

With respect to the investigation of the intended curriculum, on the other hand, all of that data has
already been collected, and the process of analysis has begun. The curriculum analysis is divided into four major components, as follows:

- **Scope and sequence analysis.**
  Each participating country has provided information about the extent to which each topic in the TIMSS mathematics and science frameworks forms part of their intended curriculum. In particular, for each topic, countries have indicated at what age or grade level the topic is introduced, when it ceases to be part of the curriculum, and in what grades or levels that topic is especially emphasized. In TIMSS circles this aspect of the study is referred to as the “modified topic tracing.”

- **In-depth topic analysis.**
  A small number of topics—-for example, solution of linear equations and measurement—have been selected for in-depth treatment at the intended, implemented, and attained levels. As part of the curriculum analysis, countries have provided detailed descriptions of the coverage and treatment of those topics throughout the elementary and secondary school curricula.

- **Document analysis.**
  At each population level, countries have provided a highly detailed analysis of representative textbooks in mathematics and science. The process involved partitioning each page of a given textbook into a number of “blocks,” and labelling the nature of each of those blocks. Several categories of blocks were defined, and coders from each country were trained in identifying and coding them according to an internationally defined standard.

  All of the curriculum analysis data is currently housed at the United States National Center for TIMSS at Michigan State University. Some preliminary analyses have been done, and they give a sense of the kind of analysis that will be possible. For example, the scope-and-sequence data can be used to provide a “snapshot” of a given country’s intended coverage of the topics included in the TIMSS curriculum framework.

  The scope-and-sequence data will enable researchers to compare the treatment of a given topic across countries and to compare the numbers of focal points as well as their placement. This analysis will provide a useful overview of differences in the way mathematics curricula are organized and presented to students.

**Conclusion**

Measuring educational achievement is difficult from both a conceptual and a practical perspective. What counts as achievement is not always easy to discern and even when a concept of achievement has been clearly explicated, ways and means for assessing it are not easily devised. The ongoing debate about educational measurement and the increasing number of alternative assessment approaches proposed in educational circles attest to this problem. Understanding or explaining causes of, or influences on, achievement is even more difficult. It is one thing to be able to describe what a student knows or is able to do in a given subject; however, it is quite another thing to explain what might account for that attainment. We know that environmental factors play a large role; yet we are not clear about how that role is played out. The educational context is a complex one, with a myriad of variables interacting with one another in complex ways. In spite of these kinds of difficulties, there are obvious reasons for wanting to assess educational achievement, not the least of which is to try to improve the educational enterprise.

The problems of describing and explaining educational achievement are compounded when considered across international settings. Curricular goals vary as do notions of achievement. Educational environments vary immensely. At the same time, an international context is a particularly valuable one for considering the importance of variables that might account for achievement. Studies that cross national boundaries provide participating countries with a broader context within which to examine their own implicit theories, values and practices. As well, comparative studies provide an opportunity to examine a variety of teaching practices, curriculum goals and structures, school organizational patterns, and other arrangements for education that might not exist in a single jurisdiction.

Being able to describe and explain achievement across countries that represent different stages of development, different cultures, and different educational systems is dependent upon detailed knowledge of the range of differences. In other words, if comparisons of achievement between and among countries are to be meaningful, a thorough description of a complex set of environmental conditions is crucial for at least two different purposes. The first is to provide a rich detailed backdrop to assist with an understanding of an education system in its particular context. The second is to provide enough detail to permit the isolation of variables that may account for differences in achievement. The task facing TIMSS is to describe, appropriately and adequately, different contexts in both the plans for assessment and in the analysis of results.

The challenge for TIMSS is to be a research activity that is useful to practitioners as well as
researchers. We believe this challenge has been met, and hope that teachers will find participation in the study as exciting as the research community does. More importantly, we hope that the teacher audience will find the results presented in a meaningful and useful way.

References

SCIENCE IN SPACE

Science in Space is a project of the Association for Science Education (ASE), funded by charity and by industry.

Space, and, in particular, the human view of space and space exploration, can provide an exciting context for students studying science. The book contains a series of units designed as a resource for science teachers who wish to present a variety of aspects of school science within the context of space.

The units were designed specially for use in science lessons with 14-16 year olds in the United Kingdom. However, in trials, they have been shown to be of use with younger and older students, in General Studies, PSE, geography and other lessons, as the basis of science club activities. Some units have been successfully trialled in schools outside the UK.

Teachers who are familiar with the Science and Technology in Society (SATIS) projects of the ASE will recognise the style of these materials.

In selecting units for their own use, teachers will be conscious of the need to take account of the language level and the assumed level of pupils' understanding. Some units are more demanding than others. Many of the units are subdivided into sections which can be tackled separately.

SCIENCE ACROSS EUROPE

Many scientific issues, such as energy supply and water quality are of common concern yet perspectives as to their causes and resolution are different. This area of science, where common ground and different perspectives meet, provides schools with an excellent opportunity to stimulate teaching by taking the European dimension into account.

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• is a new way to help teach science, languages, and economics in an environmental context
• is easy to use
• is interesting and relevant to students' concerns
• provokes discussion
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For information contact Evelyn Van Dyk, The Association for Science Education, College Lane, Hatfield, Herts AL10 9AA, UK
TEACHING AND LEARNING THROUGH INTERACTIVE MEDIA EXHIBITION

Joël de Rosnay
Director Development and International Relations
Cité des Sciences et de l'Industrie
La Villette, Paris

Training and information in modern societies requires the transfer of knowledge in the form of interdependent messages, signs, codes and symbols. These messages concern various publics and represent different levels of abstraction.

The traditional media complement one another to reinforce such communications: books, graphics, photos, slides, videos, films, interactive software - all are used in varying degrees and with their own specific features to provide the essential elements necessary for the acquisition of knowledge.

The multimedia exhibition has a particular role to fulfill in such system of educational media. Its role is to increase our sensitivities and to deepen our awareness. This type of exhibition integrates in the same space, text panels, photographs, drawings and graphics audiovisual presentations, mock-ups, and interactive equipment ranging from simple computer simulation game to complex mechanical or electronic devices. Often expensive, these exhibitions are nevertheless becoming more and more popular.

How effective are these exhibitions compared to available modern communications systems? What is their specific contribution, and how do they complement other media such as books, courses, conferences, television broadcasts, or simulation software? How will they evolve in the future in order to integrate the complexity of scientific and technical information? And, above all, how to use them efficiently in order to let visitors benefit from the presentations provided as part of a personalized knowledge route? These questions give rise to a new approach to exhibitions. It needs to be considered as an integrated communications system providing adapted and tailor-made interfaces.

The first scientific and technical exhibitions were inspired by encyclopedias: putting up texts and photographs on stands, backed up by mock-ups of real objects: instruments, machines, or heavy equipment, testimony of passed technical development. Architects and scenographers were asked to fill a space, to provide it with a coherence and a style likely to attract a visitor's attention and to keep them on the spot. The person responsible for the exhibition became literally a "producer" in spatial terms, much as we might speak of a "producer" for a film, having in this context responsibility for and control of the quality of the content of the messages intended for the visitors.

This style of exhibition (in the form of a "book on the walls") has given way, (thanks to technical progress,) to interactive exhibitions in which audiovisual techniques, computer, video disk, animated screens, and sketches performed by roboticized figures play an ever more important role.

Evaluation studies tell us that visitors are no longer satisfied reading texts or watching audiovisuals: they want to participate in experiences, do something active, answer questions, initiate new sequences of hands-on experiments. This means that exhibition planners progressively become "systems engineers" in multimedia communications. Scenographers, designers, and graphic artists have continued to play their part, but conflicts have arisen between museographic designers and animators over styles or methods of space implementation, giving preference to spectacular shows over the deep meaning of the messages.

Three types of exhibition could be described today in which the new communications technologies are used on a broad scale. The first is the "linear" exhibition, which presents a subject in a sequential manner, dividing it arbitrarily into periods (such as chronological sequences), into disciplines, or even by following a progression from the "simple" to the "complex".
The second is the “matrix” exhibition, in which no sequence as such is imposed, but where closely related sectors are presented. The interactive elements are located at the cross roads of visitor’s pathways. The third is the “discovery” exhibition, a kind of labyrinth of knowledge intended to stimulate the visitor’s curiosity by presenting elements which attracts the attention as the visitor passes down the aisle, and create a desire to learn more.

Unfortunately, these three types of exhibition only partially meet the constraints imposed by the complexity of the messages and their contents. If the elements of the museographic presentations are too detailed, there is a risk of losing the lead of the whole. An exhibition which is too analytical no longer brings about a global vision. At the opposite, an approach which is too general deprives visitors of the precise details necessary to set their imagination to work and increase the depth of their knowledge.

Added to these inconveniences are the frequent restrictions imposed by the space itself, with an overload of information resulting from the close packing of texts with photographs, audiovisuas, or interactive processes, which are difficult to understand. The lack of hierarchy among the themes and sub-themes and the weakness of the descriptions makes the messages even more confused.

It seems to me, therefore, that we need to go beyond the architectural vision alone, or the scenographic or graphic representation of a multimedia exhibition. We need to consider the relationship with the visitor placed at the center a “communications system”, and no longer think of a “communication space”.

We are therefore led to define and implement in an exhibition what I shall call from now on “intellectual ergonomics”. As with any interactive system, or computer with a direct interface to one or more users.

This involves a methodological and technical approach necessary to amplify the acquisition of knowledge by providing an adequate relationship between objects and subjects, by the simplicity of the modes of use, and by the ease and comfort of the user/machine interfaces.

For a computer, these ergonomics are translated into reality by the notion of user-friendliness. For a machine, office equipment, or a work station, well-designed ergonomics will allow for improvements in the efficiency of interrelations between user, tools, and equipment. An instrument panel, a receiver unit, a cockpit or a control system will all possess a type of ergonomics adapted to the needs of their users.

It seems to me appropriate to create multimedia interactive exhibitions by integrating the intellectual ergonomics approach into the museographic domain. The global exhibition must therefore be conceived and used as one single interactive system (and not only as an area of space equipped with interactive systems). The visitor interacts in such total system through eyes, ears, fingers, and by movement of the body through the area of exhibition.

Successful intellectual ergonomics help visitors to optimize their personal pathways in a system of communications within which they are active.

The ergonomic approach to an interactive multimedia exhibition must rest on a certain number of fundamental points.

First it is necessary to recognize and take into account the basic constraints imposed on a visitor to an exhibition. There are 4 major constraints: time, energy, money, and information.

The first three are rare resources on which we need to practice savings. But the abundance of the last (information) can lead to a saturation effect, preventing the visitor from getting any pleasure or motivation through his or her visit. An exhibition with successful intellectual ergonomics assists the visitor and help to optimize the use of time, energy, money and information through the visit.

To achieve such a task it is important to set up a clear hierarchy among the messages received, in order to facilitate guidance and reduce aimless wandering or queuing. Studies of the behavior of visitors show two major types of attitude when arriving in a new and unknown exhibit area: “scanning” with the eyes and “zapping” with the feet. Scanning consists of a visual sweeping of the spaces, panels, themes or sub-themes. This activity does not involve much energy but collects large amounts of superficial information.

Zapping is moving at random in search of interesting and relevant information. It is a natural response of the visitor expose to an exhibit area poor in information content, lacking guidelines or swamped with details.

In order to avoid passivity, frustration, or saturation with information, the intellectual ergonomics of an exhibition must rely on a global language, a “macro language”, immediately visible, accessible and meaningful. Such language is expressed first in the guides and plans provided before the visit. It should then be followed up in the scenography which creates a distinction between the major objects. Finally, it should appear in the details of the exhibition which lead the visitor from the general to the specific by offering several levels and degrees of abstraction or precision.

A guiding thread would then become clearly apparent. An overall message would be conveyed
which would form the systemic frame of reference in the course of the detailed and analytic acquisition of the elements of the exhibition.

When deprived of intellectual ergonomics, an exhibition can be compared to those modern electronic machines, video recorders, microcomputers or electronic watches with over complicated operating instructions and control panels packed with buttons and switches. We all know that 80 percent of whose functions are generally useless! Seeing users turn away from these machines designers are now competing in redesigning and simplifying controls and instructions.

The same must apply to a modern exhibition. An exhibition is a communications macromachine, made up of many levels of information transfer, buttons, notices, screens, panels, and animated models. And that is why its user-friendliness, just like the software and hardware of a computer, must be carefully designed and tested before being put into use.

A multimedia exhibition with good intellectual ergonomics presents a balance between in-depth messages and their format. Between the scientific and technical content of the messages and the way in which they are presented. It should also answer that dilemma of modern museology: do we need to give preference to overall understanding or detailed analysis? Do we want to emphasize the “macro” approach or “micro” understanding? How to present in a multimedia exhibition theme as complex as biology, ecology, the city, communications, services, finance or risk (all selected by the city of science for its major exhibitions)?

We need to talk in terms of systems, networks, control, flow, evolution. But at the same time, we need to specify details, stimulate reasoning, and provide the basis for action.

The golden rule from radio and television, “one idea at a time”, applies equally to the elements of an exhibition. But what we need is to know how to insert the details into a broader context which will allow a personalized “cognitive ecology” to be constructed by way of a dialogue with that global system of communications: the exhibition.

This “ecology” is a system of interdependent knowledge. This dialectic form of knowledge acquisition oscillate from the micro to the macro, from the local to the global, from the analytical to the systemic. What format should be given to an exhibition in order to favor this dialogue, this constructive dialectical interaction?

To achieve this, I propose a combinatorial approach using the new concepts of hypertext and fractal images.

Hypertext is a network of interconnected information. Thanks to guidelines provided by a computer, one can navigate in such a hypermedia like through a multidimensional graph. A button is clicked, and an illustrated section materializes on the screen. Clicking leads on to other connections, other sections, texts, graphics, images or sounds.

A modern interactive exhibition should be organized like a hypertext. Each node and link of the network must contain the representation of the whole, even if it provides details for a particular aspect.

Such structure looks like a fractal image.

A fractal image is a geometric shape which remains unchanged whatever the degree of enlargement under which it is being observed. Each micro image contains the macro structure.

An exhibition built with the intellectual ergonomics of each museographic element in mind and by reference to a fractal approach, will recreate at every node of the network the sense of coherence of the global entity. There are many examples of these approaches at la Cité des Sciences et de l'Industrie.

The fractal and hypertextual nature of an interactive multimedia exhibit will become a determinant factor in its success and user-friendliness. It becomes possible to create an equilibrium between museographic presentation and the richness of content of the scientific and technical messages intended for general publics.

**OUT OF THE PAST**

Never teach indoors what can be learned out of doors.
Never explain in the abstract what can be demonstrated in the concrete.
Never teach with books what can be perceived in objects.
Never teach by images when nature herself is at hand.
Never show dead nature when living nature is attainable.
Never require belief where seeing and understanding are possible.

(Dryer, 1888; 106 years ago)
Calendar
1994–1996

1994

December 6–10, 1994

The 9th ICASE Asian Symposium
Location: Bangkok, Thailand
Contact: Dr. Janchai Yingprayoon, Secretariat: IPST
Sukhumvit Rd. Ekamai, Bangkok 10110 E-mail:
OICST@CHULKN.CHULA.AC.TH

The theme of the symposium is “INCREASING THE EFFECTIVENESS OF SCIENCE TEACHING IN THE CLASSROOM: A CHALLENGE FOR SCIENTIFIC AND TECHNOLOGICAL LITERACY FOR ALL.”

December 15-17, 1994

NSTA Fall Convention
Location: Las Vegas, Nevada, USA

1995

January 4, 1995

ASE/ICASE International Symposium
Location: The University of Lancaster, UK

This will be held in conjunction with the ASE annual meeting.

January 5th–7th, 1995

The Association for Science Education Annual Convention
Location: The University of Lancaster, UK (which is 200+ miles north of London)
Contact: Dr. David S. Moore, General Secretary, College Lane, Hatfield, Herts. AL10 9AA

March 22–April 2, 1995

United States Science Education Tour
Location: Philadelphia, PA; Baltimore, MD; and Washington, DC.
Contact: Dr. Jack Holbrook, Executive Secretary, 72B Blue Sea House, 28th October Street, Limassol, Cyprus

The tour will feature various levels of science education, school visits and home stays with American families. Three days of the tour will be spent at the National Science Teachers’ Association Convention in Philadelphia, PA.

March 23-26, 1995

NSTA National Conference
Location: Philadelphia, PA, USA
Contact: NSTA 1994 Area Conferences, ATTN: T. Brent, 1840 Wilson Blvd., Arlington, VA 22201-3000

April 7-11, 1995

Science Education Research in Europe
Location: The University of Leeds, UK
Organised jointly by The Centre for Educational Studies, King’s College, University of London and The Centre for Studies in Science and Mathematics Education, The University of Leeds


April 22-25, 1995

NARST International Conference
Location: San Francisco, CA, USA

Late June/Early July 1995 (exact date to be announced)

Location: Johannesburg College of Education
Johannesburg, South Africa
Organised by the STEME (Science, Technology, Environmental & Mathematics) EDUCATION ASSOCIATION on behalf of the FEDERATION OF SCIENCE & MATHEMATICS TEACHERS.
Contact: Dr. Peter Glover
PO Box 32198
Braamfontein 2017, Johannesburg, South Africa
August 27th-September 1st, 1995

Partners in Chemical Education
An International Conference on Industry-Education Initiatives in Chemistry
Location: University of York, York, UK
Contact: Miranda Mapleton
Chemical Industry Education Centre, Department of Chemistry, University of York, York, YO1 5DD, UK
Co-Sponsors: International Union of Pure and Applied Chemistry (Committee on Teaching of Chemistry) and Royal Society of Chemistry (Education Division and Industrial Division)

August 29th–September 2nd, 1995

The International Conference on Industry – Education Initiatives in Chemistry
Location: University of York, York, UK
Organisers: IUPAC Committee on Teaching of Chemistry
The Royal Society of Chemistry
University of York

The first major international conference sponsored by IUPAC which specifically aims to promote links and dialogue between concerned industrialists and teachers from higher education, secondary and primary schools, and educational decision makers; and to evaluate and encourage good practice and discuss issues of industry – education collaboration. Correspondence/Conference arrangements:
Dr. J. F. Gibson
The Royal Society of Chemistry
Burlington House, Piccadilly
London W1V OBN
UK
Tel: +(44) (0) 71-437-8656
Fax: +(44) (0) 71-734-1227

September 4-15, 1995

Fourth World Conference on Women
Location: Beijing, China
Contact: Conference Secretariat: Division for the Advancement of Women, PO Box 500, A-1400 Vienna, Austria. Tel: 431/21131, Ext. 4270;
Fax: 431/237-495 Media: Department of Public Information United Nations, Room S-1040 Tel: 212/963-1262; Fax: 212/963-4556

This conference will:
1) review and appraise the advancement of women since 1985 in terms of the objectives of the
Nairobi Forward-looking Strategies for the Advancement of Women to the Year 2000.
2) mobilize women and men at both the policy-making and grass-roots levels to achieve those objectives.
3) adopt a "Platform for Action," concentrating on some of the key issues identified as representing a fundamental obstacle to the advancement of the majority of women in the world. It will include elements relating to awareness-raising, decision-making, literacy, poverty, health, violence, national machinery, refugees and technology.
4) determine the priorities to be followed in 1996-2001 for implementation of the Strategies within the United Nations system.

September 24–29, 1995

CONASTA 44
Location: University of Queensland, Brisbane, Queensland, Australia
Contact: David Tulip, Centre for Mathematics and Science Education, Locked Bag No. 2, Red Hill, Queensland, Australia. E-mail: D.Tulip@qut.edu.au
Tel: +64 7 864 3345 or Fax: +64 7 864 3985.

While the conference program is not finalised at this stage, it is envisaged that it will include theme lectures, symposia based on science education and workshops either based on current science research or science classroom practices. All symposia and workshop sessions will allow for personal choice and will cater for Primary, Secondary and Tertiary science teachers and science teacher educators. Educational tours of the Great Barrier Reef, tropical and subtropical rainforest, whale watching and other unique geographical and biological features of Queensland, will also be offered three to seven days prior to or immediately following the conference. A detailed synopsis of the speakers, a framework of the conference activities and a call for abstracts of papers will be available by July 1994.

September 25-29, 1995

3rd European Conference on Research in Chemical Education
Location: Lublin (Poland)
Contact: Department of Chemical Education, Maria Curie-Skłodowska University, Pl.M.C. Skłodowskiej 3, 20-031 Lublin, Poland, Dr Ryszard M. JANIUK
Tel: (81) 37-56-91
Fax: (81) 336-91 e-mail: JANIUK@PLUMCS11
The previous two conferences were held in Montpelier, France in 1992 and in Pisa, Italy in 1993. The next conferences are planned to be held every two years. The conference in 1997 will be held probably in UK. The organizers of the conference are the Federation of European Chemical Societies and the Chemical Society of the country in which the conference is held.

1996

March 28-31, 1996

NSTA National Conference
Location: St. Louis, MO. USA

July 14-19, 1996

14th International Conference on Chemical Education
Location: Brisbane, Australia
Contact: The ICCE Conference Secretariat
(Sally Brown), Continuing Professional Education,
The University of Queensland 4072 Australia
Tel: (07) 365 6360 Intl: +61 7 365 6360
Fax: (07) 365 7099 Intl: +61 7 365 7099
E-mail: chemed96@ceu.uq.oz.au

The 14th ICCE will be held in Brisbane from July 14-19, 1996. It is only the second time this conference has been held in the southern hemisphere. The biennial conference brings together chemistry teachers, chemists and science educators from school, industry and university settings to share ideas and learn from one another about innovation in teaching and learning and the discipline of chemistry. The theme, Chemistry: Expanding the Boundaries, acknowledges the centrality of chemistry through its expanding relationship with many facets of science and everyday life. Conference participants will be challenged to develop this theme with the view of enhancing our understanding of the important relationships which chemistry forms with the new frontiers of human endeavour. Implications for chemical education beyond 2000 which give a "science for all" perspective will be encouraged.

RESEARCH SAYS:

Students copy their teachers' behavioral patterns. If the teacher tries to dominate students, then students try to dominate each other. If the teacher accepts students, then students are accepting of each other.


Knowing an object requires acting on the object—modifying it, transforming it. Learning results from what one does to objects and the "doing" has to be both physical and mental.


Many teachers wait less than one second after asking a question before they answer or rephrase the question. Extending this to three to five seconds causes students to:
(a) responses to increase in length and number, 
(b) confidence to increase, (c) speculative thinking, questioning, and comparison to increase.

Extending and Improving Education in Science for All Children and Youth by Assisting Member Association Throughout the World

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Science Education International is the Quarterly Journal of the International Council of Associations for Science Education. ICASE was established in 1973 to extend and improve education in science for all children and youth by assisting member associations throughout the world.

This journal provides a means for associations, institutions, centres, foundations, companies and individuals concerned with science education, to share perspectives, concerns, ideas, and information which will foster cooperative efforts to improve science education, and which will serve as a chronicle of the advancement of science education throughout the world.

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December 1 November

ICASE News
International Council of Scientific Unions
Science, Ethics and Education Project
Teaching Ethical Aspects of Science
Report on the 7th Annual General Meeting
Galician Science Teachers Association
A Visit to Estonia
ICASE World Science Activity Week
Letter Received

Feature Article
Gender Issues in Caribbean Science Education
Chemical Education in Jordan

Science Education Around the World
S-T-S In Taiwan
Science Education in the Eastern Cape,
South Africa

Research on Curriculum,
Teaching & Learning
SciLink: An International Experiment

Teaching Materials & Strategies
Think and Do: Activity Based Science
Teaching for Primary Schools
Popular Sources of Science Resource
Materials and Teaching Strategies

Science Teacher Education &
Leadership
Improving Science and Mathematics
Teacher Education in Indonesia

Non-formal & Informal Science
Education
The Structural Attributes of Animals
Commented upon by Primary School
Children at the Zoo

Calendar
INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS
SCIENCE, ETHICS AND EDUCATION PROJECT
TEACHING ETHICAL ASPECTS OF SCIENCE
Peter J. Kelley
Director, SEE Project
School of Education
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Southampton, UK

Objectives
That scientists and those affected by science—in effect all citizens—should be concerned with the ethical aspects of science, is today perceived as a universal imperative. The Science, Ethics and Education (SEE) project aims to examine the relationships between science and ethics and to produce practical guidance on both content and method for science teachers.

More specifically the project will:
1. Define the nature and scope of ethical aspects of science relevant to general education, particularly upper secondary, early tertiary and adult community education. We will be aiming at science and non-science students and the public.
2. Define the intellectual skills and educational experiences required for understanding and decision-making related to ethical aspects of science. This entails examining the processes of ethical thinking employed by, for example, ethicists, lawyers, scientists and policy makers to see how they can be adapted for educational purposes.
3. Review the curriculum and teaching methods of relevance to the topic.

Within several developments in science education, e.g., those categorised as Issue-Science or Science-Technology-Society, there are relevant features. Other examples occur in the humanities, social studies, and newer fields such as bioethics and environmental ethics.

4. Devise curriculum units which can be adapted for a variety of educational contexts. It is intended that there should be examples which have international significance.

The uniqueness of the International Council of Scientific Unions lies in its global connections with the scientific community. Thus the emphasis of the project is on the ethics of scientific work and social issues in which scientists have a clear role. Ethical issues of gene patenting and genetic screening arising from the human genome project, and those involved when a scientist acts as an expert witness in legal cases, are examples.

Strategy and Outcomes
Phase 1 is aimed at achieving objectives 1-3. Materials and ideas are being collected from many countries. A small executive group is developing (a) policy statements on teaching ethical aspects of science and (b) a curriculum outline which could be adapted for a variety of circumstances found in different countries. Assessments will be made of human resource needs in relation to these developments. The group is also planning the work for objective 4.

Phase 2 consisted of a writing workshop in 1994 to prepare curriculum units required for objective 4.

Phase 3 entails preparation and publication of a book incorporating the materials developed in phases 1 and 2. It will consist of:
Part 1: An overview of the nature and scope of science ethics, its role in education and strategies that can be used in dealing with it. This will be written for teachers.

Part 2: Curriculum units providing teacher and student materials, in a form that can be easily photocopied.

Part 3: An annotated bibliography of some relevant materials currently available.

The basic aim of the book is to serve as a source of ideas and materials to enable teachers and programme developers to incorporate ethical aspects of science into curricula and teaching.
ICSU Overview

The International Council of Scientific Unions (ICSU) promotes international and interdisciplinary cooperation among scientists working in all natural science disciplines (ranging from astronomy and biochemistry to mathematics and pure and applied chemistry). Two distinct types of scientific organizations came together to bring ICSU into existence in 1931: national academies and research councils (such as the Royal Society and the US National Academy of Sciences), and the international scientific organizations (Scientific Unions). It is the combination of the two types—national bodies covering many disciplines, and the international bodies covering a single discipline—which make ICSU unique and help in the achievement of its objectives—to promote international interdisciplinary scientific cooperation for the benefit of humankind. Its strengths lie in the voluntary nature of the work done for ICSU by many scientists around the world, and in its determined defence of non-discrimination and independence from political considerations.

One important way in which ICSU pursues its objectives is through Scientific Committees and other interdisciplinary bodies. ICSU has Committees dealing with the environment, genetic experimentation, space and oceanic research, and many others. ICSU also launches and coordinates major international research activities (e.g., the past International Geophysical Year and the ongoing International Geosphere-Biosphere Programme: A Study of Global Change).

It also establishes committees to handle essential services and concerns that are common to the entire membership, such as the free circulation of information in developing countries. One example is the Science Education Committee, which promotes international cooperation in this important field. The Committee holds meetings and workshops world-wide. Some of its recent work includes the development of low-cost locally produced equipment for use in schools, colleges and universities of developing countries; the coordination of a worldwide programme for primary school teacher trainees; and a series of meetings to promote new science curricula with particular emphasis on national development.

REPORT ON THE 7TH ANNUAL GENERAL MEETING
GALICIAN SCIENCE TEACHERS ASSOCIATION
Xosé Mendoza Rodríguez
President, ENCIGA

Four-hundred fifty (450) Galician science teachers attended the seventh Annual General Meeting of ENCIGA, held at the “Lucus Augusti” High School in Lugo, Galicia, Spain, 17-19 November, 1994. The broad and diverse program involved more than 40 talks, workshops, and experimental demonstrations, as well as poster sessions on physics, chemistry, natural science, mathematics and integrated science. A subject which raised great interest was that of teacher training, since we are undergoing the introduction of a new educational system in Spain. Another recurring theme involved using students’ social and cultural environments to increase student motivation and to enhance the cultural aspect of Science. Other sessions included Environmental Science and Astronomy, plus eight different expositions. The meeting also attracted many mathematics teachers, and there were a number of sessions focusing on mathematics topics.

The broad program, which included social events, excursions, and visits to museums ensured that the Annual General Meeting was an enjoyable event. We’re looking forward to the next meeting.
A VISIT TO ESTONIA
Jack Holbrook

At the invitation of the Estonian Association for Chemistry Teachers (EACT), a new ICASE member association, the ICASE Executive Secretary spent a week running workshops, teaching two classes, making videotapes and giving an address to EACT teachers. The purpose of the visit was to introduce Estonian teachers to development in the teaching of chemistry and to introduce experiments linked to everyday materials that were unfamiliar.

The experiment session attracted more than 60 chemistry teachers and was set up in the school hall. The ICASE secretary was ably supported by Miia Rannikmae (secretary of EACT) and Aarne Toldsepp (president of EACT). The experiments covered the making of cosmetics (or emulsions if you prefer), distinguishing between man-made and natural fibres and the analysis of ores (dolomite, malachite). This was an ambitious programme given the surroundings, the language difficulties and the availability of equipment, but nevertheless, proved great fun. As most chemistry teachers in Estonia are female, the cosmetic experiments proved very attractive and the lack of availability of perfume on the work table did not prove an obstacle. Soon creams, shampoos, eye shadow and lipsticks were donning the tables. All creations from the ingredients provided. Production of rayon from tissue paper, using copper carbonate and ammonia proved more of a challenge, but was not hampered by the lack of safety equipment. It was, in fact very interesting to see what can be achieved with very basic equipment when enthusiasm is much in evidence.

Besides the executive secretary, both Aarne Toldsepp and Miia Rannikmae became filmstars and videotapes were made of lessons taught by all three persons. The lessons by the executive secretary were in English and the need for translation was lowered by making the lessons student-centered either by means of group discussion or by the inclusion of experiments. Student reactions, obtained in writing, to these lessons were very positive and illustrated the acceptability of student-centered lessons.

The videotapes were edited and shown to teachers in an EACT meeting. Each videotape showed a different aspect of teaching and the teachers were asked for their reactions. The videotape by Miia Rannikmae showed experimental work on the reaction of metals; simple experiments that can be easily performed to reinforce ideas on reactivity. Aarne Toldsepp gave a lesson on diffusion, again involving the students, whilst the videotapes of the executive secretary showed a lesson on the prevention of rusting of a metal bridge and the production of soap from ordinary cooking oil.

Teacher reaction was very positive, although comments were made that the approach was too time-consuming and that the amount of preparation work for the experiments was too great. The videotapes did illustrate how experimental work can be conducted and did also show how teaching can be conducted to get the students more interested and involved—areas which are of concern in Estonia. It was concluded that the visit was a success and that it had set the seeds for further developments in this area.
ICASE WORLD SCIENCE ACTIVITY WEEK
22-28 OCTOBER 1995

BRINGING PROJECT 2000+ TO SCIENCE CLASSROOMS AND COMMUNITIES
ON THE THEME OF SUSTAINABLE DEVELOPMENT
On the occasion of United Nations Day 24 October 1995

Activity Week Theme

Item 2 of the Declaration states “ . . . believe that scientific and technological literacy are essential for achieving responsible sustainable development . . . assign priority to the development and introduction of programs leading to scientific literacy and technological literacy for all with the aim of achieving responsible sustainable development.”

ICASE encourages and supports projects in science and technology education in both formal and non-formal education. To this end ICASE offers a unique opportunity for Science Teachers’ Associations to involve teachers, who in turn may involve their students in formal or informal activities in exploring, within various cultural contexts, the concept of sustainable development.

Categories
The ICASE World Activity Week aims at involving:
• Primary/elementary level students . . . ages 6-11
• Middle school/junior high students . . . ages 12-15
• Secondary/senior high students . . . ages 16-18

Activities
Student individual/group entries may be of three types:
• Poster or cartoon, paper size not to exceed 220 mm x 300 mm, in single or multiple frame format (applies to all grade/age categories). Poster or cartoon to focus on a sustainable development issue.
• Essay/paper supported by illustrations/photos focusing on a community sustainable development issue:
  • Primary (up to 250 words)
  • Junior (250-500 words)
  • Senior (1000-1500 words)
• Investigation activity which highlights a sustainable development issue. Students prepare a report focusing on the far ranging implications of the activity (applies to all levels).

Awards
Certificate awards will be available to each ICASE Regional Representative who, with an appointed panel, will evaluate the entries and recognize up to 20 individual/group entries across all categories. One special award/prize per ICASE region will also be made across all categories. A final report will highlight entries and summarize awards stimulated by ICASE World Activity Week.

ENTRIES . . . Deadline 30 December 1995
Entries may be submitted in Spanish, French, or English and are to be directed to the ICASE Representative in your region:
Africa: I. O. Ikeobi, PMB 081, Festac Town, Lagos, Nigeria
Asia: J. Yingprayoon, IPST, 924 Sukhumvit Rd, Bangkok 10110, Thailand
Australia-Pacific: M. Silis, University of South Australia, Smith Rd, Salisbury East SA 5109, Australia
Europe: A. Wojtyna-Jodko, SNPPIT, Skrytka Pocztowa 62, PL-85791, Bydgoszcz, 32, Poland
Latin America-Caribbean: J. Chamizo, Colegio Madrid AC, Calle Puente 224, 14380 Mexico DF, Mexico
North America: K. R. Roy, Glastonbury Public Schools, 330 Hubbard St., Glastonbury CT 06033, USA

Award winners will be announced in March 1996. Entries become the property of ICASE and will be displayed or put in print in ICASE publications.

For Further Information:
Mr. Bob Lepischak, Convenor, 1995 ICASE World Activity Week, PO Box 430, Neepawa Area Collegiate, Neepawa, MB, Canada R0J 1H0, Fax (204) 476-3606.
ICASE WORLD SCIENCE ACTIVITY WEEK
What is Sustainable Development? An Example.

Manitoba has always prospered through the use of our natural resources. In the past many practices for harvesting these resources were seen as being destructive to the environment. It was also recognized that our society had a great dependency on these resources and complete bans on harvesting them would be impractical. Many people separated the economy from the environment, with the belief that the two were independent from each other. Sustainable Development bridges the gap between the economy and environment.

The government recognized that responsible decision making was needed to ensure that future generations meet their needs. In 1988, the Manitoba government, in agreement with the recommendations of the National Task Force on the Environment and Economy, consented to oversee the National Task Force recommendations.

Sustainable development can be defined as a local decision making process which integrates and balances the economic, societal (health and well being of society), and environmental factors in a global context.

Philosophically, sustainable development is a grass-roots concept which requires the active involvement of all segments of society as the environment and economy are fundamental to how we live and the quality of life we have. Business, environmental representatives, labour, educators, citizens and government working together can give a balanced perspective which is not readily available to government working alone.

There are many examples of how sustainable development has affected decision making processes at all levels of our society. Manitoba Hydro provides a good example of how business is taking an active role in sustainable development. In recent years, Manitoba Hydro has adopted sustainable development as part of its corporate policy. Manitoba Hydro has implemented a plan to involve the whole corporation in implementing sustainable development policies. Projects being planned or already in progress take into consideration its effects on the economy, environment and society in whole. They have adopted a set of principles which govern how they make decisions. The principles correspond with the principles of sustainable development created by the Manitoba Round Table on the Environment and Economy.

Many governments around the world are implementing sustainable development policies that help ensure their country uses their natural resources responsibly. Sustainable development policies will continue to grow and transform with our societies changing needs.

LETTER RECEIVED
Amal Krishna Banik

Thank you very much for your excellent letter in kindly permitting us to use and translate the article ‘Teaching Science in an Artistic Way’ in Bengali language from ICASE Journal. I feel personally grateful to you for this noble gesture. I think the points Dr. Nesbitt also made are really important. I believe that much of science which seems to burden students could be better taught artistically. This is what I have come to realize through my experience of teaching for nearly two decades. So I felt inspired to bring Dr. Nesbitt’s article to my students so they could follow its inner significance as well.

Please note:
The editor would like to remind our member organizations and individual readers that all articles in Science Education International are available for reprint in your own journals. All copyrights are extended to members. This is a wonderful opportunity. Please consider starting an international section for your journal and use our fine articles to expand global awareness. All we ask is that you give credit to the author and the ICASE Journal.
GENDER ISSUES IN CARIBBEAN SCIENCE EDUCATION

Peter Whiteley
Faculty of Education
University of the West Indies

Introduction

Jamaica has about 58,000 university-age young people, of whom more than half are female. In 1992-93, forty-eight females registered for the first year introductory physics course at the University of West Indies Mona Campus. Twenty-eight completed the course successfully. By comparison there were 137 male registrations, with 76 being successful. The ratios, 2.85 male to female in registrations and 2.71 male to female in passes, are indicative of the strong male bias in physics of UWI, as elsewhere, which is further emphasized by the fact that all academic staff in the Department of Physics are male.

The imbalance, however, is evident from a much earlier stage. In Table 1 the average passes and entries in Jamaica, for 1992 and 1993, at different levels of examinations in physics are presented.

These figures make clear that physics has become a ‘male’ subject by the time students make decisions concerning their first public examinations—C.X.C. or ‘O’ Level. Decisions with regards to option choices in Jamaica are usually made during the third form of secondary school (Grade 9).

By contrast the figures for biology show a strongly female bias in Jamaica, with variation around approximate equality in chemistry although a shift towards a ‘female bias’ is noticeable at the higher levels of chemistry—Tables 2 and 3.

Working in Britain, Kelly (1987) has also noted an unequal representation of females in the physical sciences. She suggests that gender-related stereotypes place restrictions upon individuals’ development and that both the individual and society lose from this restriction of talent. She claims that science qualifications often help individuals to obtain secure and well-paid jobs which, in turn, lead to a greater degree of power and influence of such individuals in society. Science is widely held to be an important part of a general education and in the technology-based societies of today a scientific education can give people a sense of control over their environment. Kelly is of the opinion that technology is presently controlled by men, and women as a group need to be educated in science so

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<tbody>
<tr>
<td><strong>Male</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Passes</td>
<td>602</td>
<td>127</td>
<td>79</td>
<td>76</td>
</tr>
<tr>
<td>Entries</td>
<td>1836</td>
<td>293</td>
<td>129</td>
<td>137</td>
</tr>
<tr>
<td><strong>Female</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Passes</td>
<td>271</td>
<td>42</td>
<td>44</td>
<td>28</td>
</tr>
<tr>
<td>Entries</td>
<td>881</td>
<td>96</td>
<td>89</td>
<td>48</td>
</tr>
</tbody>
</table>

Notes:

1. In the Caribbean secondary school students may enter, at the fifth form, either the examinations set for the Caribbean Examinations Council (C.X.C.) or those of the Cambridge Local Examinations Syndicate (Ordinary ‘O’, level)—the figures presented here are the combined entries and ‘passes’; Grades A-C (Cambridge) and Grades 1 and 2 (C.X.C.) which are deemed equivalent and understood as passes.

2. Preliminary courses at U.W.I. are for candidates who do not have the entry qualifications for the Introductory courses—i.e., have failed or not taken Advanced (‘A’) Level in physics but have a pass at the previous level. Thus entry to introductory courses needs either an ‘A’ level pass or a pass in the preliminary examination.
### Table 2
Average Passes/Entries, Biology, Jamaica, 1992 and 1993, by Gender and Course

<table>
<thead>
<tr>
<th></th>
<th>C.X.C./ 'O' Level</th>
<th>'A' Level</th>
<th>Preliminary (U.W.I.)</th>
<th>Introductory (U.W.I.)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Male</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Passes</td>
<td>489</td>
<td>62</td>
<td>41</td>
<td>29</td>
</tr>
<tr>
<td>Entries</td>
<td>1423</td>
<td>116</td>
<td>59</td>
<td>49</td>
</tr>
<tr>
<td><strong>Female</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Passes</td>
<td>765</td>
<td>65</td>
<td>81</td>
<td>52</td>
</tr>
<tr>
<td>Entries</td>
<td>2370</td>
<td>157</td>
<td>110</td>
<td>63</td>
</tr>
</tbody>
</table>

### Table 3
Average Passes/Entries, Chemistry, Jamaica, 1992 and 1993, by Gender and Course

<table>
<thead>
<tr>
<th></th>
<th>C.X.C./ 'O' Level</th>
<th>'A' Level</th>
<th>Preliminary (U.W.I.)</th>
<th>Introductory (U.W.I.)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Male</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Passes</td>
<td>571</td>
<td>171</td>
<td>63</td>
<td>93</td>
</tr>
<tr>
<td>Entries</td>
<td>1426</td>
<td>274</td>
<td>115</td>
<td>134</td>
</tr>
<tr>
<td><strong>Female</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Passes</td>
<td>552</td>
<td>116</td>
<td>76</td>
<td>120</td>
</tr>
<tr>
<td>Entries</td>
<td>1463</td>
<td>211</td>
<td>119</td>
<td>160</td>
</tr>
</tbody>
</table>

that their voices may be heard in technological discussions. Kelly also feels that a greater involvement of women in science may lead to a humanization of science as “women whose socialization traditionally emphasizes people are well placed to reorientate science towards caring concerns” (p. 8). Bazler and Simonis (1991) note that women represent only 20.5% of the natural science and 5.8% of the engineering work force in the U.S. and express similar concerns.

In Jamaica published information is sparse as to the gender distribution of holders of technological and scientific posts, but at the Mona campus of the University of the West Indies in 1990, 53 of 65 academic staff in the Faculty of Natural Sciences were male (U.W.I., 1991).

There are a range of factors that can lead to the choices made by students in their school careers—choices that may result, in the long term, in unequal numbers of males and females in scientific and technological posts and careers. This article reports on the investigation of one possible factor—the 'gender fairness' of integrated science textbooks. Here the term 'gender fairness' is interpreted (following Bazler & Simonis, 1991) as being that the textbook contains a balanced and comprehensive portrayal of both men and women.

**Textbooks in Science Education**

Potter and Rosser (1992) suggest that teachers' reliance on textbooks results in the books playing a decisive role in determining classroom events. In Jamaica textbooks are an important part of the classroom experiences of children studying science and the textbook may effectively become a detailed syllabus for a course—thus constraining the teaching methodologies and the ideas discussed. Elsewhere, Powell and Garcia (1985) cite Stake and Easley as showing that students are very reliant upon textbooks.

Powell and Garcia (1985) argue that publishers of science textbooks should depict society 'as it was, is and should be' (p. 520) when describing scientific ideas and theories. In their view, learners should be provided with illustrations and accounts of individuals from all walks of life as being involved in science and thus provide female students with female examples of those directly involved in scientific professions and activities. This may result in less distortion and stereotyping, a more positive view of females in science and greater numbers of women aspiring to science-related professions.
Peterson and Lach (1990) note that the current recognition of the constructive nature of reading points to the importance of the prior ideas for the reader’s interpretation of the material. If readers possess gender-related stereotypes they are unlikely to question printed support for such stereotypes. These authors suggest that texts should challenge stereotypes and cite evidence that exposure to non-sexist material can reduce the prevalence of sex-role stereotyping.

Brush (1985) argues that we can reasonably assume that girls derive some kind of message from the way women scientists are mentioned (or otherwise) in textbooks and that this message has some effect on their future career decisions. Brush notes that in the rare cases of women being mentioned they are often portrayed in ways that would not be considered models of success by students reading the material.

Most of the science books used in high schools in Jamaica are published in Britain although they are usually authored or co-authored by Caribbean writers. Books written specifically for the Caribbean first became generally available in the latter half of the 1970s. Research elsewhere at that time was demonstrating that many science textbooks had a clear bias towards males. Taylor (1979) looked at three popular physics texts in Britain and found many references to males (youth and adult) with very few references to females and when girls or women were shown they were not depicted in activities of a scientific nature. Historically, references were made almost exclusively to male scientists and the technological examples chosen were those of greater interest to boys than to girls. Recent work (Jones & Kirk, 1990) has shown the considerable differences which can exist between the examples of applied science that are of interest to boys or girls. Throughout the texts that Taylor studied, the image of a woman as a passive, domestic being was promoted with the references to females largely confined to domestic situations.

Heikkinen (1978) looked at American chemistry textbooks from the 1940s to the 1970s and demonstrated the all-pervasive nature of the sex-stereotyping and bias. Male figures were shown to dominate all the textbooks including the most up-to-date revisions. Named and unnamed adult figures were on average 83% male in the 1970s textbooks with the illustrations of youths or students being in the male to female ratio of two to one in the same textbooks. Bazler and Simonis (1991) followed Heikkinen’s methodology and used later editions to look for changes between the early 1970s and the late 1980s. Overall, they found significant differences in the male to female ratio in the later texts compared with earlier editions in relation to gender fairness. Only in one text was a balance between male and female illustrations found.

Powell and Garcia (1985) analysed elementary level books and found that although females were depicted throughout the illustrations in a variety of occupations they were represented in these roles less often than males. On the other hand female children were found to be represented more frequently than male children in both scientific and non-scientific activities suggesting that publishers have made progress in improving the image of young females in science texts. Recent work by Potter and Rosser (1992) has indicated that most texts now use gender neutral language and depict women in illustrations. They claim, however, that more subtle forms of sexism may still be detected, the contributions of women scientists are often omitted and topics of interest to women are overlooked. They found a significant sexist bias in science textbooks (all published in 1983 or 1984) and argue that the omission of women’s contributions and interests supports a stereotype in which only male interests are worthy of recognition and study.

Methodology

This study had the objective of analysing a popular two volume integrated science textbook series published for use in the Caribbean (Books A and B, see appendix) and comparing the results with those from sample volumes of each of four other series of integrated science textbooks (Books C-F, see appendix). One volume from each of three integrated science textbook series published for use in Britain were also analysed. (Books G-I, see appendix.) The intent was to determine the gender fairness of the textbooks being used in Jamaica, to draw relevant comparisons with the British textbooks and to attempt to identify possible changes that might be considered desirable.

The following aspects of the textbooks were considered:

(i) the number of illustrations of males and females, both youth and adult and the total number of illustrations;

(ii) the number and gender of named scientists in the text or illustrations; and,

(iii) the prevalence of the depiction, in words or illustrations, or ‘gender stereotypes.’

The selection of the textbooks for the study posed certain problems. Teachers in Jamaican high schools enjoy a considerable degree of autonomy and the Ministry of Education does not prescribe the textbooks to be used for the teaching of a given
discipline or year group. This leads to an uncertainty as to current practice and firm data as to which textbooks are used and to what extent textbooks are not available. It is, however, reported that the Books A and B are commonly recommended on school book lists for the first three years in Jamaican high schools. It is hoped that the exercise reported here will at least give pointers for further investigation and research.

**Results**

The figures in Table 4 show that a clear bias exists towards the representation of adult males as opposed to adult females in the illustrations in the two books (A and B) of the main series as adult scientists, technologists and in related occupations. On the other hand, young people of either gender, who are usually shown engaged in the laboratory activities described in the text, are depicted in approximately equal numbers. It could be suggested that the image given is one in which all students, independent of gender, are expected to play an equal role in school science but that in adult life science is a province more appropriate for males. The large percentage of illustrations without humans in both editions should also be noted.

### Table 4

**Distribution of Types of Illustrations, Caribbean and British Integrated Science Textbooks**

<table>
<thead>
<tr>
<th>Book</th>
<th>Total Pages</th>
<th>Total Number of Illustrations</th>
<th>Adult Male</th>
<th>Adult Female</th>
<th>Youth Male</th>
<th>Youth Female</th>
<th>No Human Depicted</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>140</td>
<td>266</td>
<td>15 (5.6%)</td>
<td>6 (2.2%)</td>
<td>26 (9.8%)</td>
<td>29 (10.9%)</td>
<td>190 (71.4%)</td>
</tr>
<tr>
<td>1989</td>
<td></td>
<td></td>
<td>2</td>
<td>0</td>
<td>24 (8.1%)</td>
<td>24 (8.1%)</td>
<td>210 (71.1%)</td>
</tr>
<tr>
<td>B</td>
<td>172</td>
<td>295</td>
<td>228 (9.5%)</td>
<td>9 (3.1%)</td>
<td>24 (8.1%)</td>
<td>24 (8.1%)</td>
<td>210 (71.1%)</td>
</tr>
<tr>
<td>1989</td>
<td></td>
<td></td>
<td>6</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>126</td>
<td>152</td>
<td>10 (6.6%)</td>
<td>7 (4.6%)</td>
<td>12 (7.9%)</td>
<td>12 (7.9%)</td>
<td>111 (73.0%)</td>
</tr>
<tr>
<td>1988</td>
<td></td>
<td></td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>141</td>
<td>213</td>
<td>7 (3.3%)</td>
<td>3 (1.4%)</td>
<td>12 (5.6%)</td>
<td>8 (3.8%)</td>
<td>183 (85.9%)</td>
</tr>
<tr>
<td>1990</td>
<td></td>
<td></td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>141</td>
<td>204</td>
<td>17 (8.3%)</td>
<td>8 (3.9%)</td>
<td>18 (8.8%)</td>
<td>20 (9.8%)</td>
<td>141 (69.2%)</td>
</tr>
<tr>
<td>1991</td>
<td></td>
<td></td>
<td>10</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>188</td>
<td>215</td>
<td>17 (7.9%)</td>
<td>9 (4.2%)</td>
<td>10 (4.6%)</td>
<td>3 (1.4%)</td>
<td>176 (81.9%)</td>
</tr>
<tr>
<td>1992</td>
<td></td>
<td></td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G</td>
<td>119</td>
<td>384</td>
<td>73 (19.0%)</td>
<td>13 (3.4%)</td>
<td>22 (5.7%)</td>
<td>21 (5.5%)</td>
<td>255 (66.4%)</td>
</tr>
<tr>
<td>1986</td>
<td></td>
<td></td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>158</td>
<td>464</td>
<td>28 (6.0%)</td>
<td>18 (3.9%)</td>
<td>82 (17.7%)</td>
<td>108 (23.3%)</td>
<td>228 (49.1%)</td>
</tr>
<tr>
<td>1988</td>
<td></td>
<td></td>
<td>5</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>141</td>
<td>328</td>
<td>51 (15.5%)</td>
<td>30 (9.1%)</td>
<td>29 (8.8%)</td>
<td>37 (11.3%)</td>
<td>181 (55.2%)</td>
</tr>
<tr>
<td>1988</td>
<td></td>
<td></td>
<td>7</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Key: Named—Named Scientists

10
Science Education International, Vol. 6, No. 1 March 1995
Both books of the series include no named examples of female scientists. The argument might be put forward that female scientists were not involved in the development of any of the content in these textbooks but perhaps a lack of knowledge of such contributions, on the part of the authors, may be a factor.

All the other Caribbean and British textbooks considered have greater proportions of male figures than female figures in illustrations. The ratio in favour of males is generally greater for the illustrations of adults than for the illustrations of young people where an essential numerical equality is achieved in five out of seven textbooks. Thus generally, perhaps, "Science is for all school students but for male adults" may be the message being received.

The figures do not suggest that any of the textbook series is clearly preferable to the others from the point of view of equality of representation of the genders. It should be noted that the percentage of illustrations in the Caribbean textbooks without a human depicted varies from 69.2% to 85.9%; the British textbooks surveyed had a substantially lower percentage of this type of illustration—49.1% to 66.4%. An impersonal view of science may well be conveyed by such a large number of 'human-free' illustrations which may have implications for gender perception and preferences. The textbooks for British students also had considerably greater numbers of illustrations per page on average. The Caribbean textbooks had between 1.14 and 1.90 illustrations per page with an average of 1.47 while the British textbooks had between 2.33 and 3.23 illustrations per page with an average of 2.81. This may reflect an effort to reduce costs for the Caribbean textbooks and also difficulties that the British publishers may have in obtaining illustrations suitable for the Caribbean.

Figures alone, however, do not adequately describe the textbooks' treatment of gender-related issues. Although the Caribbean textbooks do not use the masculine pronoun in references to scientists and are generally neutral in language use, neither do they actively challenge gender stereotypes. The potential for such a challenge is well exemplified by Book I—a book intended for British lower school students. In this textbook a decision appears to have been made to deliberately present examples which avoid implicit gender stereotyping. The illustrations in this book include persons shown engaged in the following activities:

<table>
<thead>
<tr>
<th>Female Figures</th>
<th>Male Figures</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 Pot-holing</td>
<td>1 Vacuuming</td>
</tr>
<tr>
<td>1 Washing clothes</td>
<td>1 Washing clothes/holding baby</td>
</tr>
<tr>
<td>1 Drying clothes</td>
<td>1 Drying clothes</td>
</tr>
<tr>
<td>1 Firefighter</td>
<td>1 Firefighter</td>
</tr>
<tr>
<td>1 Deep Sea Diver</td>
<td>1 Deep Sea Diver</td>
</tr>
<tr>
<td>1 Lifeguard</td>
<td>1 Attending Birth</td>
</tr>
<tr>
<td>1 Sky Diver</td>
<td>2 Air traffic controllers</td>
</tr>
<tr>
<td>1 Gas Station Attendant</td>
<td>2 Air traffic controllers</td>
</tr>
<tr>
<td>1 Giving Birth</td>
<td></td>
</tr>
<tr>
<td>1 Doctor</td>
<td></td>
</tr>
</tbody>
</table>

The list above indicates that there can be a range of opportunities in a science textbook to provide alternative perspectives to common gender stereotypes. Further, most, if not all, of the activities or occupations listed are, or contain, examples of technological applications of the physical sciences—given the low numbers, noted earlier in this article, of women in the physical sciences the emphasis in these illustrations could be seen as important. (The only other book with similar 'challenging' illustrations was Book H which is also a book for British students.)

The near total lack of named female scientists in the Caribbean textbooks (two, both in Book D) is clearly an element in the production of such textbooks that authors and publishers may wish to address. Textbook D has mention of two female scientists—the well-known Marie Curie and June Roach, the latter a Barbadian microbiologist who works in the veterinary field. This text also names three male Caribbean scientists and outlines their work—in the writer's view the utilisation of Caribbean examples of practising scientists should be encouraged with a further need for gender equality.

Work into images in Caribbean social studies textbooks (King & Morrissey, 1988) found that females, along with their achievements and contributions, tended to be ignored or underrepresented. Nearly fifty percent of the textbooks reviewed were found to use masculine nouns and pronouns to include women as well as men. Thus the general problem identified in this paper in Caribbean science textbooks appears to be found in other disciplines as well.

**Conclusion**

Overall most of the integrated science textbooks used in Jamaican high schools exhibit a male bias although authors and publishers now appear to be more aware of the need to check textbooks for gender balance. In the production of science textbooks
decisions regarding the illustrations may often be
made by the publishers with a tendency to use
material they already possess for convenience—this
may go some way in explaining the relatively slow
rate of change. It is also possible that there has not
been as much societal pressure in the Caribbean as in
England aimed at ensuring a strict equality of
representation of the genders and attempting to
challenge gender stereotypes.

It has been suggested that when historical
examples are being discussed the social context
should be explored to ‘explain the predominance of
men in science at the time’ (A.S.E., 1990, p. 6).
Further, the ‘hidden’ contributions of women
scientists in history might be good starting points for
discussion (see Alic, 1986).

It is to be hoped that a consideration of these
issues will guide decisions made by authors and
publishers in their continuing revisions of current
Caribbean science textbooks and the development of
new materials.

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C. Butler, P., D. Carrington, G. Ellis with
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E. Williams, (1991). New Integrated Science for the
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Science, Book Two. Nelson Caribbean,
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CHEMICAL EDUCATION IN JORDAN

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Irbid, Jordan

Teaching chemistry in Jordan started in the early 1950s. At that time there were no laboratory experiments. Only lectures were given to students and they had to learn by rote. Later (1964) laboratories were set up and chemical reactions were occasionally demonstrated to the students.

A. Pre-school & Lower Basic Stage
Chemistry teaching in schools begins at the primary levels as a part of the integrated Science curriculum which begins formally from primary 3 onwards. From the first year at school (age 6 years old) students are exposed to studies on “Matter” which includes studying about the properties of water, air and other materials, elements, magnets, and changes in specific properties as a result of interactions with other matter or energy, or both.

Another important consideration is that in Jordan practically all children have at least one year of pre-school experience. Even in the kindergarten they are exposed to various materials and their properties. Concepts of color, weight, hardness, texture and even density are experienced through play and related learning experiences in a pleasant way.

One can thus appreciate the early start these young children have in Science.

B. Middle Basic Stage
Chemistry is given more prominence at the Lower Basic stage, age 10-14 years. It is offered as an integrated part of General Science which is taken by all students. Topics in General Science include:
- Laboratory set-up, arrangement, rules and safety in the laboratory.
- Measurements—SI units and use of common laboratory apparatus are introduced.
- Matter—classification of matter, states of matter and changes in matter.
- A simple introduction to elements, mixtures and compounds.
- Simple concepts of atoms and molecules in terms of the distinction between atoms and molecules.
- A brief study of air and its components.
- A brief study of water and solutions.
- An introduction to hydrogen, acid, bases and salts.

C. Upper Basic Stage
At the Upper Basic Stage, age 14-16 years, while at the 10th grade (16 years old) chemistry and earth sciences are taught as separate subjects. At the end of this stage students are divided into different streams, scientific and literature (academic education) and professional education such as agriculture, nursing, and industrial stream.

D. Secondary Level
Chemistry is available as an elective subject at secondary level. Unlike in the basic stage, 11th grade and 12 grade chemistry is a separate subject. It has its separate books, separate laboratory and more advanced chemical subjects start to be taught such as polymers, transition metals, organic chemistry, and some industrial subjects. Only specialists in chemistry teach these courses.

E. Junior College
The colleges and polytechnic, which are under the Ministry of Higher Education, offer chemistry programmes at the diploma level (two years) after the national secondary school examination (Tawijihi).

The Junior College core syllabus represents 80% of the entire course with 20% drawing option topics. The core syllabus comprises the theoretical and established concepts of Chemistry while the option topics are geared towards applications of Chemistry. The topics include:
1. Phase Equilibria
2. Further Transition elements
3. Biochemistry
4. Chemical Engineering
5. Food Chemistry
6. Polymer Science
7. Soil Chemistry
8. Spectroscopy

The syllabus is still focused on the core areas, and the questions are more demanding requiring higher levels of thinking skills on the part of the students.

F. Chemical Education at Universities

Undergraduate Study in Chemistry
In 1964 the first faculty of science in Jordan was established at Jordan University. The first chemistry building at this university was ready to function in
Since then, the chemistry building has expanded according to the increasing need. The Department of Chemistry at Jordan University, under the leadership of qualified and enthusiastic professors has made a great contribution to the development of chemical education in Jordan. It has been their graduates who have been involved in establishing most of the chemistry departments in other universities. The number of chemistry departments is gradually increasing. Out of the six state universities, there are three departments of chemistry and a department of applied chemistry has been started at Jordan University of Science and Technology (JUST). Besides state universities private universities started four chemistry departments, but have fewer students.

All the programmes offered lead to bachelors degrees and require a minimum of 132 credit hours spread over a four year study period. For a programme with a single major in chemistry, the chemistry units are 99 units minimum requirement. In the double major programme the load of chemistry is slightly reduced to 29-30 units. Jordan Universities are practicing the cumulative Average system. Under the system, those who obtain: 84% and more excellent; 76%-84% very good; 68%-76% good; 50%-68% poor; less than 50% fail.

In the first and second years the curriculum covers basic chemistry to strengthen the understanding of chemical concepts in physical, inorganic and organic chemistry. Practical classes, which account for about 25% of the total chemistry loads, are compulsory. Chemistry normally attracts large numbers of students and this usually gives rise to logistic problems to the department. The third and fourth year chemistry subjects are considered as core courses with possibilities of taking some elective subjects from chemistry or other disciplines. In the fourth year some specializations are offered in the field of analytical chemistry, physical chemistry, inorganic chemistry, material, polymer and environmental chemistry.

In the fourth year some students are required to carry out research projects. These research projects provide students with the opportunity to choose their field of interest and to work independently with close supervision by their supervisors. However, as these projects create great demands on facilities and academic staff, some universities provide option for students to skip the research project and replace it with course work.

Every year, all Jordanian universities produce about 280 chemistry graduates. Most of the chemists are employed as teachers in secondary schools, some are in the institutions and industries while others are in administrative lines. The demand for chemists is great as many new industries require chemists in their operation. This is the reason few chemist graduates pursue higher degree studies.

Postgraduate Studies in Chemistry

At Jordan University and Yarmouk University, the enrollment of chemistry postgraduate students is around 5% of the total undergraduate students enrolled. Efforts are being made to increase the graduate student population to around 20-30%. This is not an impossible figure to achieve in the near future as the country moves towards higher education industrialization. This process requires indigenous research and this will naturally push local industries to demand highly trained research chemists. In many industrialist countries it isn’t uncommon to find higher proportion of post-graduate chemistry students than their undergraduate counterpart.

Under normal circumstances only chemistry graduates with at least a good average (70% up) who have an interest and an attitude for research can be eligible to do post-graduate studies which lead to Masters (M.Sc.). Graduates with lesser qualifications who have enough working experience as school teachers can be eligible to do postgraduate studies in science education. Master degrees are for those who would like to solve a minor research problem and at the same time gain some experience in research activities.

All of the postgraduate chemistry programmes are conducted through full time research. Only occasionally are some candidates required to take a few credits of course work to strengthen their background in a particular field of chemistry.

Most of the post-graduate research in chemistry evolves around primary commodities with emphasis on pollution, water treatment, drugs, etc. Apart from these applied oriented research projects, fundamental research on pure chemistry is also offered.

Problems of Chemistry Education

This universal problem of teachers who are not fully qualified, inexperienced, and underpaid applies also to the teaching of chemistry, as in the other subjects, but here the problem is accentuated by other factors applicable to chemistry.

High school chemistry combines all the exacting topics of an exact science and the dullness of factual knowledge. With an inexperienced teacher chemistry can become extremely boring, uninteresting and unchallenging.

Students learn chemistry just because it is a part of the curriculum, not because of the subject itself.

We all know that experimentation could evoke much more interest and make chemistry more
attractive, enticing students to study chemistry for itself and opening their minds to the challenges of chemistry. Unfortunately experiments are not utilized by most teachers for the simple reason that they were not exposed to it in their own senior high experience.

Most schools lack laboratory facilities, but books on chemistry are readily available. There is a book packet written by a team of the Ministry of Education and Universities and there are many others by individual writers, many of which are quite good and up to standards. This learning material is not the biggest constraint as proven in many schools where a resourceful teacher can do a lot of experimenting with "nothing," using only discarded empty bottles, drinking glasses, vinegar borrowed from the kitchen, hibiscus flowers from the garden and so on. It is true that these teachers are exceptions, but they do exist and one can imagine what they could accomplish when given adequate facilities. But even with such teachers and facilities, we all are familiar with chemistry experiments in high-school, which in Jordan are usually carried out as lecture demonstrations. These, even when performed perfectly, can be observed clearly from front seats only. Still, when properly organized, lecture demonstrations can go far in at least making chemistry eye catching, interesting and attractive. It would be far more effective if the students could carry out experiments individually; unfortunately very few schools are in a position to do that and even in these few schools the students work in groups. The cost is still prohibitive for students to carry out experiments individually.

If possible, individual experiments would force the students to think and make them remember facts much more easily. When they actually see an indicator changing color they will remember it much more easily than just by reading it.

Besides this material constraint, it should be realized that most teachers are not able to face the challenge of organizing individual student's practical work and maybe do not fully realize its importance, for the simple reason that it was not emphasized in their previous teacher training. This constitutes a challenge to the IKI's as the source teachers, and indeed the Ministry of Education are not in the process of revising the curriculum.

Another, much more serious constrain to promoting practical work is the system of examinations. In the system of examination, the final examination (Tawjih) gives no weight to practical work. It is more important for the student to find the correct answer rather than to really understand concepts.

It is true that experimenting does help in finding the correct answer but because teaching time is limited, so much to teach in so little time and experiments certainly can be very time consuming, a teacher (especially inexperienced) will be inclined to sacrifice practical work and put emphasis on the teaching itself.

Should he spend one lecture hour to set up a lecture demonstration of the dissociation of nitrogentetroxyde or would it be more useful to use that one hour to train the students in how to calculate the concentrations of a certain solution. For the average teacher, harassed and pressed for time, the choice will be obvious.

### Attempts to Improve Chemical Education in Jordan

Some programmes are organized very pragmatically and are school-based so as to interfere as little as possible with the teacher's regular activities. A cluster of schools located not too far from each other are selected and one (usually the best equipped and staffed) is chosen as a meeting point where the teachers meet with the acting members of the Jordanian Chemical Society. The meetings are not so much a one-way course, but more like an open discussion and thus can be very productive. Each teacher can bring forward his own particular problem and the topic for the next meeting is decided.

To extend the Jordanian Chemical Society services, new branches of the society were established in other districts of the country, and some members of the Ministry of Education joined the society to act as instructors.

It should be noted that the progress of chemical education in Jordan is not accomplished by the formal educational system solely.

Other activities organized by The Jordanian Chemical Society also play an important role. Further activities include the following:

1. Meetings and workshops of the Jordanian Chemical Society.
2. Chemistry training by the Institute for the Promotion of Teaching Science and Technology.
3. Activities of the Chemistry departments which have received the kind attention and support of universities and the Ministry of Education.
4. Activities of the Department of Curriculum and Instruction in preparing teachers to get their diplomas in Science Education (two years after B.Sc.) also have been introduced.

For more information, please contact the author.
References

“A WORLD IN MOTION:” PHYSICS FOR PRIMARY SCHOOL CHILDREN

More than 100 corporations have joined forces to create and fund a program to teach physics concepts to grade school children (The Engineering Society for Advancing Mobility Land Sea Air and Space International press release).

“We’re losing an entire generation of children because they’re being turned off by science,” said Lloyd Reuss, retired president of General Motors and one of the brain trusts supporting “A World in Motion.” “Our public schools don’t have the resources themselves to reverse this trend,” he added. “A World in Motion is proving to be a particular successful response to this challenge.”

The program centers on a hands-on physics and math curriculum “featuring carefully researched practical experiments” and the involvement of professional engineers and scientists. According to the release, more than 10,000 engineers and scientists have volunteered 50,000 hours of time assisting teachers and students. A recent survey of teachers using the program in their classrooms found that 90% said their students had strengthened their physical science skills and another 70% stated that student math skills had improved, writes the release.

“A World in Motion” was launched by a $1M gift from General Motors, and SAE has raised $7M from corporations including Allied-Signal, American Honda, Siemens Automotive, Toyota, Rockwell, Nissan, Chrysler, GTE, Caterpillar and the Eaton Corp. And a National Science Foundation grant of $1.8M will help expand the initiative to middle schools nationwide, reports the release. SAE also intends to raise an additional $16M during the next six years to expand the initiative and support the middle school program.

“A World in Motion” kits are distributed free-of-charge to elementary school teachers. Already 20,000 kits have been sent to 10% of public schools nationwide. SAE’s goal is to make the program available to 80% of the nation’s elementary schools, writes the release.

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412/776-4841.
Science Education Around the World

Member associations and individuals are invited to contribute to this section. Suitable items include brief accounts of specific projects of international significance, science education in a particular country, or international and regional seminars and conferences.

S-T-S IN TAIWAN

Cheng-Hsia Wang
Department of Chemistry
National Taiwan Normal University

An Idea for Educating STS Literate Teachers

Science-Technology-Society (STS) education is distinctly different from traditional schooling. Educating science teachers to be STS literate can be achieved with strategies that help them construct appropriate beliefs, values, and professional practices. This paper proposes one teacher education strategy.

This strategy makes three assumptions: (1) Citizens literate in STS must be cultivated through STS related social issues. (2) STS literate students can be cultivated only by STS literate teachers. (3) STS pedagogical content knowledge (PCK) can be constructed only through actually participation in STS learning.

In our plan, preservice teachers engage in a problem centered STS activity using role playing, small group cooperative learning, and class sharing. The entire process is videotaped. The videotapes provide opportunities for articulation and reflection among the peers. In the process they confront inconsistencies between the traditional one and the STS instructions and come to construct more appropriate beliefs, values, and science teaching practices.

Our beliefs, in designing the strategy, are:
1. Learners as designers of instruction and learning by doing in authentic contexts are powerful tools for educating science teachers.
2. PCK can be developed through a problem centered STS activity.
3. Small group cooperative learning triggers natural instincts to construct PCK.
4. Role playing is useful in facilitating brainstorming, arousing issue awareness, finding questions, seeing multiple perspectives, and assuming relative positions.
5. Students learn better when given intellectual autonomy, which encourage them to negotiate differences and work toward consensus.
6. Videotaping activities provides opportunities for articulation and reflection. In conclusion, teachers training institutions should provide formal STS courses so that preservice teachers can have opportunities to design and use their own STS activities to construct PCK. They should be encouraged to maintain efforts along this line to assure that the college training would be far more than just cosmetic.

The Role of the National Science Council

Teaching and learning in Taiwan has been strongly affected by the national curriculum standards and the joint entrance examinations. As a result, it has been difficult to implement STS as a teaching/learning strategy in the schools, although many educators realize its importance. To encourage STS efforts, the National Science Council Division of Science Education launched the STS movement by promoting science education research. This research effort is headed by Division Director Dr. Rong-Fu Hsu.

They began with a workshop, planned by Senior Research Fellow Yung-Wen Kuo and jointly organized by National Science Council Division of Science Education, National Taiwan Normal University Institute of Science Education, and National Taipei Normal College Department of Science and Mathematics.

Held at NTNU, August 23rd-27th, 1994, more than one hundred science educators attended the workshop. Dr. Robert E. Yager, of the University of Iowa, was the keynote speaker in the workshop. Lectures and discussions were conducted on the following topics.

Day 1: The meaning of STS
The constructivist learning model
Constructing a model for student learning in science
Historical review of science education reform

Day 2: The Iowa Chautauqua Program
Assessment of changes in teacher and student learning
STS and the national standards and curriculum frameworks
Structuring STS modules (Examples)
Day 3: Teaching strategies needed for STS
   Video-tape analysis/review
   Action research and changes in teaching approach
Day 4: Assessment instruments and strategies for implementing STS in schools
   Practices in formulating researchable questions
   Relating quantitative and qualitative techniques
   Matching goals with assessment
   Strategies/instruments
Day 5: Identifying research projects for each participant team

Reporting and communicating
   Instructional modules
   Research questions and approaches
After the workshops educators are organizing collaborative STS research projects and seminars to facilitate information exchange. A cordial invitation is hereby extended to STS experts worldwide who are interested in international cooperation; please write the author at:
   Department of Chemistry,
   National Taiwan Normal University
   88 Tin-Chou Rd. Section 4
   Taipei, Taiwan 11718, R. O. C.

SCIENCE EDUCATION IN THE EASTERN CAPE, SOUTH AFRICA

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Introduction
The Eastern Cape is one of the nine recently proclaimed provinces of the “new” South Africa. It is the second largest province in the country, covering an area greater than countries such as Lesotho, Malawi, Austria or England and caters for nearly two million pupils, i.e., 25% of the South African school-going population.

Eighty percent of the population speak Xhosa, 10% Afrikaans and 5% English. However the medium of instruction in the vast majority of schools is English, starting in the third year.

Although the Eastern Cape has 25% of South African pupils, it produces only 6% of the country’s matriculants. Nearly 70% of all teachers in this region are considered under or unqualified. These data are indicative of general problems plaguing education in the province. The position of Science Education is even more parlous as only one out of every 10,000 black pupils who begin formal schooling leave the system with a passing grade in Physical Science and Mathematics.

- lack of support mechanisms, e.g., science societies, groups, committees, etc.
- overcrowded classrooms
- lack of facilities in general, e.g., many schools do not have electricity and some farm schools do not even have access to water.

This situation prompted a number of private-sector sponsored initiatives in science education. These programmes usually took the form of in-service training and classroom support, both at elementary and secondary level. One such programme is the Primary Science Programme (PSP) which is a national initiative with management structures in five provinces. This programme has operated for over ten years in the Eastern Province in collaboration with the University of Port Elizabeth’s Centre for Continuing Education (CENCE). Since its inception in 1984 the programme has grown more than twenty-fold from 58 teachers at 32 schools to the current figure of well over a thousand teachers in 800 schools.

Problems and Intervention
The problems encountered when teaching science in the new South Africa remain the same. These are:
- lack of training in Science Education
- lack of apparatus and supporting materials
- teaching Science in a second language

Materials and Methods
The initial intent of the Primary Science Programme (PSP) was to provide elementary schools with science apparatus and to train teachers to implement practical work. Currently apparatus is still provided to schools in kit form. The kits provide all the prescribed experiments in years 5, 6 and 7. Enough apparatus is provided in each kit for ten
groups of pupils, but smaller, five-group kits are also produced for farm schools. These kits are currently assembled at CENCE and distributed to schools via PSP in-service training workshops. The cost of the apparatus to schools is 20% of the cost of production. Over 500 schools in the Eastern Cape have been provided with at least one kit.

International trends and developments have had, and continue to have, effects on science education in the Eastern Cape and a great deal of curriculum development has taken place in the Primary Science Programme since its early days. Currently the programme’s in-service training focuses on teacher development through integrated concept-methodology workshops which attempt to create a change in attitude from valuing content to valuing skills and concepts. Activities emphasize the constructivist learning model.

As the programme is presented over an area equivalent to the size of England implementors are drawn whenever possible from local communities. These include lecturers from universities and colleges, science advisors, school teachers, farm school managers plus “home managers” who are qualified to teach science at school level. Staff development of these implementors is promoted by quarterly seminars during which the content, methodology and philosophy of the programme is discussed. These seminars, which are held at central venues, also facilitate coordination and administration.

Lack of materials per se, as well as the perception that the materials that are available do not support the programme’s aims and philosophy, prompted the development of materials for teachers and pupils. Worksheets, which include numerous cartoons and illustrations to stimulate interest and promote understanding, were tested on teachers during workshops, as well as by teachers in the classroom. Over 250,000 copies of worksheets were made available to schools for testing and teachers became part of the development process through editing and putting forward new ideas. After this process was complete, workbooks were made available to schools at a price less than the cost of production.

Another problem experienced in the classrooms of the Eastern Cape is the authoritarian methods used by many teachers. This probably reflects on their own experiences as pupils and subsequent training at College. This authoritarian approach remains a problem despite strenuous attempts at remediation during workshops. In response to this a series of “prompt posters” were developed to promote teachers questioning skills and encourage pupil participation in lessons. The prompt posters, which are draped over “holdall lecterns,” have a series of lesson prompts on the side facing the teacher. These prompts are almost entirely in the form of pupil directed questions. Examples of acceptable answers are included with the prompts.

The posters, worksheets and in-service training workshops all follow the prescribed elementary school syllabus and, wherever possible, promote the use of the apparatus provided in the kit supplied by the Primary Science Programme (PSP).

Rationale

The underlying rationale which directed the development of materials was shaped by the belief that they should:

- present concepts as visually and concretely as possible
- allow concepts to be built up in a logical way
- be pleasurable, challenging and interactive
- allow mastery of small steps with opportunity for demonstrable achievement, leading to confidence building and more complex skills
- emphasize oral, written and other communicative skills
- allow pupils with restricted language competency to demonstrate their skills and understandings
- create a change in attitude from valuing content to valuing skills and concepts

Apart from the above, the thinking which directed the development of the prompt posters in particular was they should:

- make explicit the intent underlying the lesson as this leads the teacher to security and focus
- enable learners to easily grasp what is intended through pictorial aids and verbal prompts
- allow users to become part of the development process through pupil and teacher input during testing and trialing
- be able to be put into immediate practice in the classroom
- be a model which is transferable to other subjects and which allows teacher to produce posters by themselves.

The cartoons on the worksheets and posters are meant to make the activities fun, reading more pleasant, help pupils make sense of new words and provide visual stimulation for concept formation. Varied worksheet layouts allow pupils to experience different ways of presenting and recording information.

The Future

Although cooperation between the PSP, Shell Education Service and the university has enabled the
development of a synergistic programme for both the in-service training of science teachers and the development and production of apparatus and materials for schools, there are a number of issues which require attention. One is research into the effect of these efforts in the classroom. Another is the issue of accreditation of the upgrading efforts of underqualified teachers, particularly those in remote rural areas who have little opportunity to interact with formal training institutions. Both these issues are currently receiving serious attention.

It is hoped that on-going research will provide a sound framework for further developments and that accredited in-service training, integrating science, mathematics and the medium of instruction, and which focuses on classroom competencies, will provide an incentive for teachers to develop themselves into effective science/mathematics educators while using their second language as the medium of instruction.

Figure 1: Areas of operation of the Primary Science Programme in the Eastern Cape, South Africa.
Scale: 1cm = 50km
Figure 2: Cartoon style worksheets for pupils

Figure 3: Example of "discussion about instances" type prompt posters which fall under the category "Force," showing the illustration and teacher prompt on the back.
Stem Link: AN INTERNATIONAL EXPERIMENT

Lynn W. Glass
Iowa State University, Ames, Iowa
Eugenia Etkina
Southwest High School 1543, Moscow, Russia

When we think of international exchanges among high school students most of us think about exchanges involving foreign language, humanities, or social studies classes. It doesn't have to be that way. We want to share with you an unique experiment called Stem Link; an exchange that involves high school students of science in three Iowa high schools and three Moscow high schools.

During the summer of 1991, the National Science Teachers Association (NSTA) and the Soviet Academy of Science jointly sponsored a conference in Moscow designed to bring together science educators from the U.S.A. and the U.S.S.R. An outgrowth of the conference was the firm conviction that many mutual benefits would be obtained from an open exchange of ideas and materials between Russian and United States science educators. An exchange of subsequent visits by the co-authors of this article led to the development and funding of the Science Linkages Project (Stem Link); a project with the goal of improving the level of student achievement in science and cultural understanding.

Stem Link begins in September each year when students and teachers in Iowa and Moscow are linked via the Internet for the purpose of the daily sharing of teaching ideas and materials, student generated science data, and information about school life, values, and interests. Students and teachers are paired for the purposes of exchanging communication and home-stay visits. In February, the participating Russian students and teachers stay in the homes of their Iowa hosts. Teachers share teaching duties and students attend a full load of classes. In April, the participating Iowa students and teachers spend a month in Russian home-stays. Because few Iowans speak Russian the Iowans tend to assist in the teaching of English rather than of science and do not take a full load of courses.

Internet, our linkage, is a world-wide electronic data and communications network established by the National Science Foundation. The over one million daily users communicate via the same language, TCP/IP protocol. Teachers and students in Stem Link use modems and low technology computers, either Macintosh or MS-DOS based, to connect with Internet.

The utilization of Internet for daily correspondence allowed the project co-directors to watch the interactions of Stem Link teachers and students as they became familiar with one another and commenced the development of shared teaching and learning activities.

The average number of messages per week was 54.75. The 30 Iowa students and three teachers generated 25.03 messages per week while the 30 Moscow students and three teachers generated 23.28 messages per week. The administrative staff generated 6.44 messages per week.

While there were 54.75 messages during an average week, there were approximately 125 “conversations” during an average week. Each message contained 2.3 topics. A content analysis of one-third of the messages indicates that nearly one-half, 48.8%, of the conversations were cultural in nature; one-third, 32.1%, were academic in nature, and one-fifth, 19.1%, were technical/administrative in nature. Our sampling for content analysis was done for the September through January time period.

Improving our level of science achievement and gaining a cultural understanding of one another begin with a firm foundation of communication. Internet proved to be an inexpensive, practical way to communicate across nine time zones. Messages sent from Moscow on Tuesday were received in Iowa on Tuesday. The language used for communication was English.
Our teachers shared many ideas over the Internet. They shared philosophy, goals, lesson plans, teaching techniques, and student evaluation materials. While on the two one-month home stay visits they shared teaching materials and equipment, led class discussions, and helped write new science lessons. Follow up activities this year indicate that teachers are still utilizing texts, computer disks, laboratory activities, and teaching ideas that were shared during the exchange program last year.

The science project initiated by two physics teachers illustrates the cooperation that took place in SciLink. Each of the 20 students (10 from Moscow and 10 from Iowa) was responsible for a quantitative investigation of a topic in physics. Investigations were started in the fall of 1993 and were completed in the spring of 1994. Teachers and students helped one another regardless of country of residence.

During the last week of February, 1994, a physics demonstration program was held at Ames High School for parents and friends of the participating students. During this program, participating students gave oral presentations and visual demonstrations describing the results of their research. A video tape was made for viewing in Moscow by parents and friends.

A SciLink Physics Booklet was published. This booklet contained individual summaries written by each student describing his or her laboratory investigations. Summaries contained quantitative data, including graphs and mathematical equations. Conclusions were written including ideas for further investigation.

Topics investigated included:
1. The effect of air friction on the motion of falling coffee filters
2. Superball collisions
3. Home-made electric guitar
4. The frictional effects on a hover-craft
5. The effect of atmospheric pressure on a coke can
6. Potato battery
7. Bernoulli effect on a garbage bag
8. Cheap electric motor
9. Standing waves in a flaming pipe
10. Measurement of force exerted by strings
11. Photoelectric effect
12. Pendulum with vibrating support
13. Total internal reflection of a laser beam
14. Properties of sound waves using a vibrating thread
15. Convection currents caused by rotating cylinders
16. Visual effects caused by rotating colored discs
17. Alternating current demonstration using reversed diodes
18. Visual demonstration of standing waves in a vibrating metal plate

Students learned to work together during this project. Each of the physics teachers had the opportunity to work with small groups of students throughout the project. Justifying the many hours of work involved in this project was the strong sense of accomplishment and pride felt when the project was completed.

Another project was initiated by a chemistry teacher in Iowa and a chemistry teacher in Moscow. Because of the historical significance, they decided to study Dmitri Ivanovich Mendeleev, a Russian chemist who is credited with creation of the periodic table of the elements. Students in Moscow and in Iowa researched Mendeleev's life and contributions to science. When Russian students visited Iowa reports were given and differences were noted and discussed. Students from both countries learned a new perspective to chemistry. In addition, the Russian students had an opportunity to practice their English language skills.

Because Iowa students lacked Russian language skills the Iowa chemistry students devoted much of their time while in Moscow to assisting with chemical experiments, an area in which they possessed much expertise. A lot of chemistry was learned during these activities in addition to gaining in cultural and language understanding.

Perhaps student comments are the best way to summarize the cultural value of a project like SciLink. The following are verbatim student comments to the question, "Please identify what you feel will have the most lasting value from your SciLink experience?" The comments were part of a final written evaluation. Can you tell which statements were made by Iowa students and which ones were made by Russian students?

The most important thing that this exchange has given me is a better understanding and appreciation for the differences between our two cultures and countries. I have a much better perspective of my own home now, and am very glad to have gained this. I believe this experience will be one of the most benefiting to me of my entire life.

I think the most lasting value for me is that Russian and American families have more similarities than differences and people of both countries have very similar moral principles and goals of life.

The way my family took me in and treated me as their own will probably be the most lasting value from my trip. I didn't feel shut out or anything. I was a part of the family from beginning to end.
I now understand that people from different parts of the world are pretty much the same. I could communicate with them and they could understand me! We don’t need any conflict between us.

The long lasting relationship between another person and another culture. I learned the differences and similarities between our two cultures because of this trip. I value most the friendship between me and my host.

Thanks for this great opportunity. We have a lot of new friends, impressions, and knowledge. All the people whom we met were very nice to us, so I have very warm feelings about this project. And also, the science part of this project was very interesting and useful for me.

It is clear to the 71 persons (62 high school students and nine adults) involved in SciLink that international exchanges and cultural understanding can be accomplished through science classes. Science is an international language. We study the same concepts and utilize many of the same classroom strategies to achieve student learning. Science provided us with a common language to achieve true international understanding.

Internet proved to be an effective means to link science students and teachers from widely differing cultures. We urge you to continue our “international experiment” and bring the young people of the world together to explore science. Remember, students in our classes today are the scientists of tomorrow. If we foster better international scientific understanding today, we have a better world tomorrow.

Key to student quotes (first to last): Iowa, Russia, Iowa, Russia, Iowa, Russia

Lynn W. Glass is a past president of the National Science Teachers Association and a professor of science education at Iowa State University. Eugenia Etkina is a physics teacher and methodologist at Moscow High School 1543. Dr. Glass and Ms. Etkina presently are directing SciLink II, involving over 100 students and teachers during the 1994-1995 school year.

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8TH INTERNATIONAL ORGANIZATION OF SCIENCE AND TECHNOLOGY EDUCATION (IOSTE) SYMPOSIUM EDMONTON, ALBERTA, CANADA

Alberta Education will be hosting hundreds of international participants at the 8th International Organization for Science and Technology Education (IOSTE) Symposium in August 1996.

What is IOSTE?
IOSTE is an organization committed to advancing the cause of science and technology education as a vital part of the general education of all people in all countries of the world. As well, IOSTE identifies the changing science and technology education needs of humankind and nations. The members of IOSTE are approximately 600 science and technology education policy and decision makers in regions that include the Arab States, Australia and Oceania, South and East Asia, Africa, North and South America, and Eastern and Western Europe.

What is the 8th Symposium Theme?
The symposium’s theme is Science and Technology Education for Responsible Citizenship and Economic Development: Evidence, Policy and Practices. One of the intents is to acknowledge fundamental changes in the economic climate, and make the connection between education and the workplace. This topic is becoming increasingly important to people in Alberta, Canada and other parts of the world.

The theme also addresses two emerging demands of science and technology education worldwide; preparing students to:

- make appropriate decisions regarding local and global environmental issues, and make wise use of natural resources.
- contribute toward responsible economic development in a highly competitive and integrated global economy.

Inquiries and calls for proposal forms can be directed to:
Raja Panwar
8th IOSTE Symposium, Curriculum Standards Branch, Alberta Education
Devonian Building, West Tower, 11160 Jasper Avenue
Edmonton, Alberta Canada T5KOL2
Telephone: (403) 427-2984  Fax: (403) 422-3745  Internet: RPanwar@edc.gov.ab.ca
Teaching Materials and Strategies

This section focuses on the education of science teachers, and aims to communicate ideas and strategies which will assist science teachers to enhance and enrich their programs.

THINK AND DO: ACTIVITY BASED SCIENCE TEACHING FOR PRIMARY SCHOOLS

J. O. E. Otuka

The central theme of the ‘Think and Do’ approach is that of creating a challenge, thereby, conforming to the current constructivist philosophy. The program develops young pupils abilities to plan, effect, interpret, draw inferences and communicate the outcome of their experiments. Critical thinking skills are applied in interpreting the challenge, recalling relevant experiences and designing a solution. This involves negotiations with others as well as clearly sorting out what procedures will be followed and what items of equipment will be used. In the ‘Think and Do’ approach, pupils in small groups are expected to follow the sequence in the circular chart as shown in Figure 1.

The initial stimulus is provided by a bright photograph presented in an activity card. The activity cards are designed either to be popped up or held by a child as a group plans the activities to meet the challenge. Each card has an extension activity for further investigation, again through the trigger of a photograph. For example in the sample activity structure 6 - ‘Wobbly animals,’ there is such an extension activity: Investigation further; Do long legs or short legs make it easier for animals to stand up? This activity is an extension. Each card also has a list of words (vocabulary) that are discussed with relevant examples and suggestions for “before” and “after” dialogue to stimulate discussion.

The group members can talk, make suggestions and plan a strategy to meet the proposed outcome. The questions for discussion are designed to assist the teacher working alongside with children to initiate dialogue after the preliminary identification of items and associated recall and observations.

During the Harare Generator, an event held at the University of Zimbabwe in 1991, African Science educators shared experiences and generated new ideas for science teaching and teacher education. This was after a variety of specialized inputs by Science Educators and other resource persons mainly from Britain and a few from the United States of America. The Think and Do approach was pilot tested by a group of African Science Educators under the supervision of Sue Dale Tunicliffe. The African educators made the following modifications to the approach:

- the glossy work cards were replaced with locally produced sheets to reduce cost.
- the teacher used intervention questions to assist the pupils during activity sessions to avoid inactivity.
- locally available materials were used as much as possible.

A Sample Activity

One of the activities carried out under this approach was: Working with Magnets. The details are as briefly described below:

Objectives: The pupils should be able to:
- group a given set of materials into magnetic and non-magnetic substances.
- compare the strength of magnets.
- determine whether two identical magnets used together are twice as strong as one.
- play some games using the power of attraction of magnets.

Materials Provided

Piece of stone, biro, pencil, paper clips, drawing pins, piece of paper, copper wire, scissors, straw, a nail, leaf, rubber band, ruler, plain sheet of paper, circular and rectangular magnets, two puppets with magnets attached, two magnets mounted on long sticks and a carton cut open at both ends.

Probing Questions

The following questions were posed to the pupils to encourage them to discuss among themselves and determine the tasks as well as challenge them:

- Do magnets attract all objects?
- How can you show this?
- How can you tell how strong a magnet is?
• Would a strong magnet pull a magnetic material from further away than a weak magnet or the other way round?
• Can you play a game with magnets?

The pupils used the Think and Do process as in Figure I to carry out the activity.

The evaluation questions were as follows:
• Did the magnet attract all the materials?
• What general statement can you make from your findings?
• Which magnet attracted material from further away than the other?
• Did putting two magnets together improve their strength to attract objects from further away?
• What game did you play with the magnets and puppets?

Results: The pupils followed Figure I and reported their findings under ‘we discovered’ . . . The summary of their findings is as follows:
• Magnets attracted paper clips nails and drawing pins but did not attract biros, pencils, leaves, copper wire and rubber bands. Magnets do not attract all objects.
• The larger and stronger magnet attracted materials from further away than the smaller and weaker magnet.
• The two magnets put together attracted materials from further away than the other magnets which shows that they are stronger.
• The puppets were moved about and collided with each other at times.

The pupils negotiated among themselves through trial and error processes. They rotated responsibilities and tried out new and different possibilities. There was curiosity as well as anxiety to find solutions to the task. However, as the activity progressed the clever pupils tried to dominate the others in participation. The discussions became very hot arguments at the end when results were to be argued and agreed upon.

Like all teaching methods, the ‘Think and Do’ approach has its merits and demerits. Some of these are stated below.

**Merits**

The approach is easily adaptable to local demands. Pupils develop competence in reporting the outcome of their activities.
• Pupils use evidence impartially
• Pupils cultivate the habit of working successfully with others in groups
• Pupils manipulate materials using their own plans and initiative and
• Pupils are able to raise questions among themselves and search for answers.

While some of the demerits are:
• The approach consumes time. A lesson can hardly be accommodated by the time schedule on the time table. It requires a lot of extra work from the teacher.
• It makes the class noisy.

In recent times, many teaching approaches have emerged in which the pupil takes responsibility of constructing knowledge by himself/herself.

‘Think and Do’ approach is a tested constructivist approach to primary science teaching. You may like to try it.

The originator and author of the ‘Think and Do’ cards is Sue Dale Tunnicliffe, the Coordinator of ICASE STEPPING INTO SCIENCE WORLDWIDE. Prof. J. O. E. Otuka led the ‘Think & Do’ trial team during the Harare Generator.

The Think and Do series, 5 titles, is available from Simon and Schuster Young Books, Campus 400, Maylands Avenue, Hemel Hempstead Herts, UK and were originally published by Basil Blackwell, Oxford. The titles are: Materials, Living Things, Energy, Soul & Shy, Ourselves and the Environment.

**ICASE Award Scheme**

For outstanding contributions to international science education

Nominations for these awards must be forwarded by member associations of ICASE. For full details of how to forward nominations, contact the Executive Secretary below.

**ICASE Distinguished Service Award**

This award is made to individuals who have a career history of distinguished service to international science education through their involvement in the international activities of local regional and global science education organisations

**ICASE Regional Service Award**

This award honours individuals who have made a significant contribution to international science education through their involvement in international activities at the local and regional levels

**ICASE Association Award**

This award recognises individuals who, within their science teacher association, have made a significant contribution to the international activity of their association

Contact Dr. Jack Holbrook, Executive Secretary
ICASE, PO Box 6138, Limassol, Cyprus

26

Science Education International, Vol. 6, No. 1 March 1995
POPULAR SOURCES OF SCIENCE RESOURCE MATERIALS AND TEACHING STRATEGIES

Ken R. Mechling Ph.D.
Professor of Biology and Science Education
Clarion University, Pennsylvania

For more than thirty years I have presented staff development programs in science to elementary teachers all over the world. All during that time—from Iceland to Samoa, from Kenya to Malaysia, and from the United Kingdom to Russia—I have found one need expressed time and again; the need for high-interest, hands-on activities teachers can do in their classrooms tomorrow. Teachers want easy-to-do science activities they can do with children.

This universal need seems to be sparked by several circumstances. First, good teachers know that children respond favorably when they are actively involved in topics which interest them. Children are interested in animals so classroom visitors such as ants, snakes, worms, or small mammals can be wonderful resources for science. Children can learn much about sound by making and playing their own musical instruments. And they can begin building ideas about density by predicting and testing objects to observe if they sink or float. Children are highly interested in such activities and are, in fact, following the tenets of modern constructivist theory by constructing their own meaning from real experiences. Teachers like to do such activities because they are fun and exciting for the students.

The second reason that teachers want high interest, hands-on activities is to spic up the science textbook that usually forms the basis of their curriculum. Texts are for reading and the few activities included in them too often tell the answer before the children do the activities—taking away the surprise and much of the fun. Or text activities require specialized equipment that is not available. Teachers become bored and frustrated. They seek alternative experiences to interest children. They search for activities that require simple, easily-accessible materials, for example paper strips that can be transformed into neat helicopters for studying air pressure and gravity or seeds found...
locally that can be used for classification or flashlight
cells, bulbs and aluminum foil strips that make
wonderful electrical circuits. Teachers are forever on
the look-out for high-interest activities to enhance
text-based curricula.

A third reason teachers desire ideas for neat
hands-on activities is that they are either saddled with
a dull, boring, or inappropriate science curriculum or
they lack a science curriculum altogether. In such
circumstances a rich source of science activities can
become the spine of a home-made science
curriculum. Anyone familiar with the National
Wildlife Federation series of NatureScope books will
be delighted with the easy-to-use, interest-grabbing
activities in books such as Trees are Terrific, Wild
About Weather, and Astronomy Adventures. Such
references are full of high-interest science activities
and content information. They could easily form the
backbone of an exciting science curriculum.

One of the richest sources of teaching ideas is a
group of references generally called supplemental
curricula. Supplemental curricula are those resources
which include ideas for teaching materials and
instructional strategies but are seldom viewed as a
traditional, comprehensive, textbook-based
curriculum. Rather, they are resources which provide
teachers with interesting, easy-to-use activities—the
kind they can use tomorrow, the kind that could fit
any science curriculum.

Based on experiences in hundreds of science
teacher staff development programs throughout the
United States and at least fifteen countries around the
world, there are clearly some supplemental science
curricula which are very popular among teachers.
These are the teaching materials that teachers
gravitate toward, the ones they want copies of, the
ones they use for enhancing the science learning
experiences of the children in their classrooms.

The following sections will describe briefly only
seven of the most popular supplemental science
curricula. Included is the title, curricular area, grade
levels, cost in U.S. dollars, publisher and order
information and a brief description. Readers desiring
a more comprehensive but selective list of resources
for science materials and instructional strategies can
request in writing, by telephone or FAX the Guide to
Supplemental Science Curricula and Resources:
Elementary through High School Levels. Requests
should be sent to the Pennsylvania Center for Science
and Technology Education, Main Street, Box 330,
Shippenville, PA 16254; telephone 814-782-6301; FAX 814-782-6453.

***

**Title:** Kaleidoscope

**Curricular Area(s):** Science & Children’s Literature

**Grade Levels:** K-3

**Cost:** $15.00/year for 10 issues

**Back issues available**

**Publisher & Ordering:**

Kaleidoscope
Wisconsin Academy of Science, Arts & Letters
1922 University Avenue
Madison, WI 53705
Tel: 608-263-1692

**Description:**

Kaleidoscope is printed in a 6-page newsletter
format, focusing on a wide variety of science topics.
The uniqueness of this publication is the way it
introduces each science topic by using a children’s
book. Through the book, science concepts are
presented, along with other integrating activities for
language arts, math, art, drama, music and social
studies. Bulletin board ideas, bibliographies,
interesting facts and hands-on science activities and
science activity pages are also included. Focuses of
some of the more recent issues include The Arctic,
Camouflage, Marsupials, Snakes, Bats, The Senses,
Soil and Temperature.

***

**Title:** NatureScope

**Curricular Area(s):** Life, Earth, Environmental
Science

**Grade Levels:** K-7

**Cost:** $7.95/guide or $99.00/18 volume library

**# Guides/Books:** 18

**Publisher & Ordering:**

National Wildlife Federation
Dept 337
1400 16th Street, NW
Washington, DC
20036-2266

**Description:**

Each NatureScope issue contains teacher background
information and hands-on student activities around
that issue’s theme. Titles include Astronomy
Adventures, Incredible Insects, Wading Into Wetlands,
Endangered Species, Wild About Weather, Rain
Forests: Tropical Treasures, Amazing Mammals and
Geology—The Active Earth, Trees are Terrific and
Digging into Dinosaurs. Activities use inexpensive,
easily accessible materials and are accompanied by
“Copy Cat” pages for student record keeping or
make-and-take materials.

***

Science Education International, Vol. 6, No. 1 March 1995
Title: Activities Integrating Mathematics and Science (AIMS)
Curricular Area(s): Science and Math
Grade Levels: K-9
Cost: $14.95/book
# Guides/Books: Approximately 30
Publisher & Ordering:
AIMS Education Foundation
PO Box 8120
Fresno, CA 93747-8120
Tel: 209-255-4094 FAX: 209-255-6396

Description:
The AIMS curricular materials consist of teacher-written classroom-tested activities using a hands-on approach to interrelate science and mathematics. The books are grouped by concept area, grade level or theme that promotes science and math experiences kids will find in the real world. Most AIMS activities can be done with easily-obtainable materials including school supplies like paper clips, note cards and scissors and grocery store items such as cereal, candy, gum, fruits and vegetables. Sample titles include Critters, Sinkers and Floaters, Budding Botanist, The Sky's the Limit, Find Your Bearings, From Head to Toe, Mostly Magnets and Primarily Physics.

* * *
Title: Great Explorations in Math & Science (GEMS)
Curricular Area(s): Science and Math
Grade Levels: Pre K-10
Cost: $7.50 - $15.00/book
# Guides/Books: 33
Publisher & Ordering:
GEMS
Lawrence Hall of Science
University of California
Berkeley, CA 94720
Tel: 510-642-7771 FAX: 510-642-1055

Description:
GEMS teacher guides focus on science concepts in the life, earth and physical sciences. GEMS activities reflect the use of guided discovery and cooperative and collaborative learning using easy-to-obtain materials. Each guide is organized around a science or math concept/process such as chromatography, bubble-ology, consumer science, electricity, predicting, probability, etc. Titles include Acid Rain, Liquid Explorations, Mapping Animal Movement, Cabbages and Chemistry, Ladybugs, Height-o-Meters, Fingerprints, Oobleck, Hide a Butterfly, Magnifiers and others.

* * *
Title: SuperScience (Red & Blue editions)
(Subscription edition published Sept-May)
Curricular Area(s): Science and Science activities
Grade Levels: 1-6
Cost: $5.75/yr/student (Red edition)
$6.50/yr/student (Blue edition)
Publisher & Ordering:
Scholastic SuperScience Magazine
PO Box 3710, Dept 6001
2931 E. McCarty Street
Jefferson City, MO 65102-3710
Tel: 212-505-3000

Description:
SuperScience is a monthly magazine for elementary students and teachers. Published as two different editions (Red for Primary, Blue for Intermediate) it brings into the classroom meaningful hands-on science activities, take-home science, and science information relevant to children's interests. Each issue is filled with challenging activities stressing the connections of science with other elementary curricular areas and the real world. Recent themes include Creepy Crawly Bugs, Our Mom, Whales, Things We Can't See, Muscles "N" Bones, Seed Needs, Measuring Memory, Color De-Coding, Satellites in Orbit and Deep Sea "Flight".

* * *
Title: Elementary Science Olympiad Fun Day
Curricular Area(s): Science activities
Grade Levels: K-3
Cost: $15.00/book (3rd ed)
Publisher & Ordering:
Science Olympiad
864 Schoolhouse Lane
Dover, DE 19901

Description:
The Elementary Science Olympiad Fun Day book includes 31 activities which involve primary children in non-competitive, hands-on experiences in science which emphasize participation, teamwork and cooperation. Fun Day events include Barge Building, Bubble Trouble, Airplane Throw, Rock Hunt, Life Cycles, Tin Can Race and Pattern Blocks. Olympiad experiences in life, earth and physical science will heighten students' and teachers' enthusiasm for science thinking skills, science content and application of science to the real world. Olympiad guides are also available for the elementary, middle and high school levels.
* * *

**Title:** Brown Paper School Book Series

**Curricular Area(s):** Elementary/Middle level subjects

**Grade Levels:** K-9

**Cost:** $9.50/book

**Publisher & Ordering:**
Delta Education
Box 950
Hudson, NH 03051
Tel: 800-442-5444  FAX: 603-595-8580

**Description:**
This series of activity books is written about a variety of subject areas and designed for kids and grownups together. Presented in a humorous fashion they are full of information and activities. Titles in the series include Blood and Guts, Gee Whiz, The Reasons for Seasons, Big Beast Book, Good for Me, My Backyard History Book, The Book of Where, Only Human, Mathematics for Smarty Pants, The I Hate Mathematics Book, The Book of Think, The Night Sky Book and others.

**Section Editor's Comments:**
One of the roles of ICASE is to facilitate the exchange of ideas and resources for teaching science around the world.

The following paper suggests sources available within the USA that have been used by elementary teachers around the world to interest pupils, to spice up textbooks and to be the focus of a home-made curriculum.

We would welcome information from colleagues who have used the sources referred to here or others.

We are anxious to identify sources of science materials produced in other countries and to learn of their use. Please send information to the Section Editor at CES, King’s College, London, Cornwall House, Waterloo Rd., London SE187X, UK

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30 Sept 1995  Last day for early registration.

For further information & guidelines for abstracts contact:

JISTEC '96 - The Programme Committee, P. O. Box 57005, Tel-Aviv, 61570, Israel.
E-mail: jistec@vax.trendline.co.il  Fax: (972)-3-512-4833
Science Teacher Education and Leadership

This section focuses on the education of science teachers, and aims to communicate ideas and strategies which will assist science teacher educators to enhance and enrich their programs.

IMPROVING SCIENCE AND MATHEMATICS TEACHER EDUCATION IN INDONESIA

Dr. Robert K. Sembiring

Editor’s note: There are many approaches to improving pre-service and in-service teacher education. In the December issue Dr. Mehru from Karachi wrote about a Teacher Resource Centre which was founded by teachers for teachers: a grassroots approach. In this issue Dr. Sembiring describes the efforts of the Indonesian Basic Science Team which is involved in improving pre-service teacher education on a national scale. The team started as a curriculum team, scientists trying to design a new curriculum for science and mathematics teacher education. However, the team did not stop after producing the curriculum, but got actively involved in implementation. The team learned much about grassroots level problems, developed more complex views on teacher education and evolved into a semi-permanent committee initiating and coordinating a wide range of activities to improve teacher education.

Summary

Indonesia teacher education was created in 1954. Initially there were only four institutes. Now there are 33 state institutions and 201 private ones. Their curricula have changed several times: from stress on science content to stress on teaching and back to science content. The Basic Sciences Team was created in 1989 to improve and develop the science teacher education faculty. The team has revised the curricula, produced textbooks, upgraded 50% of the lecturers and is currently working to develop five growth centers.

Historical Background

Indonesia is a vast country, consisting of more than 3000 inhabited islands with a population of more than 180 million people distributed very unevenly, more than one-half in Java. The age distribution of the population is young, the rate of growth is decreasing rapidly, currently around 2%.

In the early years of its independence, Indonesia had no ready-made model of an educational system. The school system was fashioned to Indonesia's own needs and aspirations rather than modelled on the practice of a highly developed commercial and industrial nations. The growth of schools and universities in Indonesia has been extraordinary, particularly from 1956-1965. Political pressure from each province to have a university was very high. From 1966-1971 the rate of expansion, though still high, dropped markedly (Beeby, 1979).

The central government for very good reason emphasizes equity in education. According to the latest data, in the course of the First Period of the Long Term Development, 1969/1970-1993/1994, there was an increase in participation rate (the ratio of enrollment to the total number of school age children) of 280% for the primary school, 320% for the junior secondary school, 390% for the senior secondary school, and 690% for the tertiary level (Education Consortium, 1994).

A student can choose to enroll in a state school or a private one. All the schools have to follow the state guidelines determined by the Government in Jakarta. Except for some local content, a curriculum is decided in Jakarta. In the early periods of educational development, central planning and control were used effectively to direct efforts toward quantitative expansion as well as establishing quality standards. The system has since grown too complex for central planning to be efficient, resulting in the Government and the public becoming increasingly critical of the nature and quality of the education being given.

Secondary Teacher Education

Before 1954 Indonesia took its secondary teachers from the regular academic departments of the universities on the assumption that knowledge of subject-matter was the essential thing and that teaching methods could be picked up in practice. Thus, the training in pedagogic theory and practice began from nothing (Beeby, 1979).

In 1954 the teacher education institution was created giving bachelor’s and master’s degrees. There were four of them at that time, all of them state institutions. Two years later they were attached to universities as faculties of education under the title of FKIP (Faculty of teacher training and educational science). Due to great demand for teachers many FKIPs were created afterwards. In 1963, four of them were removed from the universities and established as separate institutes under the name IKIP (Institute of
teacher training and educational science). Currently there are 10 state IKIPs and 21 state FKIPs in the country. In addition, there are 201 private teacher education institutions (IKIPs and FKIPs). The state LPTKs (IKIP and FKIP) enroll about 240,000 students with about 28,000 S1 (equivalent to a BA degree) graduates a year, and the private institutions enroll 166,500 students with about 13,000 S1 graduates per year (Balitbang Dikbud, 1993). Since inception the LPTKs have shown themselves to be inefficient, unable to attract the brightest students to teaching and a considerable part of their graduates fail to enter the teaching profession.

In the mid-seventies criticisms were leveled at LPTKs that the courses they offered were not very relevant to future teachers’ interests and many experts suggested the need for better teacher training, meaning more emphasis on preparation for teaching. Before 1979 the curricula of FKIPs and IKIPs put heavy stress on content-subject compared to teaching content.

From 1975 to 1979 a great effort was made by the Director General of Higher Education (DGHE) to establish curricula that stress teaching competencies (10 competencies). A team of experts was created, with consultants from the World Bank, to write the curricula and all LPTKs were then required to adopt them. In practice many did not adopt. Again, less than 20 years after the use of these curricula, there were many public outcry leveled at the LPTKs. Many observations indicated that the average achievement of high school graduates over the years, especially in mathematics and natural sciences was decreasing (LAPI, 1985). It was unfair, of course, to level all the criticisms at the LPTKs, but they were the most easy scape-goat. Quantitative achievements such as the tremendous growth in enrollments, do not go hand-in-hand with qualitative achievements. One is usually achieved at the expense of the other. However, the public usually does not want to hear of this excuse.

A curriculum committee was set up in 1983 and proposed new curricula for IKIP. These curricula stressed heavily on subject matters. However, these curricula were never implemented. The six IKIPs in Java took steps in devising their own curricula in Science and Mathematics Education in line with those of 1983. About 75% of the total semester credits was allocated for subject matters. At this juncture the morale of the academic staff of LPTKs was low. Public pressure was very high, at one stage there was even talk of closing the LPTKs and moving the teacher education to universities. DGHE decided to find ways to improve the LPTKs.

One logical way of improving the quality of education at the secondary level, though long range in nature, is to improve the pre-service training of teachers. Due to budgetary constraints, the DGHE felt that it should give priority to the basic sciences (mathematics, physics, chemistry, and biology) in pre-service training. In 1988 the DGHE created the Basic Sciences Team (will be called the BS Team hereafter) with the main task to improve the science and mathematics teaching at the LPTKs. The BS Team comprises of four members from the Institute Teknologi Bandung (pure science background) and five from the IKIP Bandung including one expert in curriculum development. I am from the Mathematics Department of ITB and the team leader. The major source of funds to finance the BS Team’s activities is a World Bank loan.

**Development of the Basic Sciences Teaching**

As mentioned above the members of the BS Team come from different backgrounds. It took a while for the Team to establish a common platform and much longer to recognize the dimensions of the whole problem of science teacher education. Because four members of the Team are from outside of LPTK, acceptance of the Team, at least in the first year, was quite problematic. Many prominent staff of the LPTKs felt the existence of the Team as an intrusion on their territory.

There were many factors which contributed to the low achievements of high school graduates in mathematics and natural sciences in the middle of the eighties. One of them was the surge of secondary school enrollment due to quantitative expansion at the primary level so that the LPTKs as the main suppliers of high school teachers had to increase their input and output levels. Also the Government created crash-programs to meet the increasing demand for high school teachers. LPTKs do not attract the best high school graduates. This is even more true for science and mathematics teacher education at the LPTKs. A study conducted in 1985 by LAPI ITB, commissioned by the DGHE showed that the graduates of LPTKs in the field of mathematics and natural sciences took, on the average, more years of study than those in other fields in the same institution.

Almost all of the LPTKs suffer from a shortage of qualified teaching staff. Most of the existing staff have poor academic capabilities. Inbreeding is a common way of recruiting staff. In 1985, more than three-quarters of the existing staff only had a BA (or S1) degree. They also showed very poor command of English. Several years of observations indicated that the performance of the graduates of LPTKs who took a graduate program at ITB, was much lower than expected. Now they are required to take a one-year Pre-S2 program before being allowed to take S2 (masters) study at ITB.
There is a widely shared perception that LPTKs tend to be ‘closed’ societies, inadequately linked to the universities, to the schools, and to the broader community. Very few of the senior teacher educators have ever worked as classroom teachers, though many of the juniors moonlighted as classroom teachers to supplement their low income.

**Curriculum**

After intensive review of the present and all the previous science curricula of the LPTKs, the BS Team decided to make major revision of the current ones. In other words, the team decided to choose curriculum as an entry point to the very complex problem, many parts of it not academic in nature.

There were two reasons for selecting this entry point. Firstly, it was considered easier and secondly, to give more time for the Team to be more acquainted with the problems. This adjustment period, it turned out, was very crucial.

Since none of the members of BS Team had any bureaucratic experience the team approached the problem diametrically different from the previous curriculum committees. We realized that the efficacy of a new curriculum depends in some measure on the method adopted for setting it up. The people who work under it have to feel in some way responsible for it. On the other hand, in a country as huge as Indonesia, the school system should be regarded as an instrument of national unification. The implication is that the curricula have to have a common core of subject content for every field of study. Also, we believe that whether science is to be taught to future scientists, or to future citizens, there is a pressing need to ensure that the secondary science teacher, whose role is so crucial, has the educational background necessary to rise to both challenges.

With help from several experts from each field of study (mathematics, physics, chemistry, and biology) the BS Team wrote a first draft of the curriculum for each field of study. We wrote it in terms of core-topics and called it the core curriculum (see Annex). Another new feature of the curriculum is that it has what we called the First Common Year. All first-year students in mathematics, physics, chemistry, and biology are required to take the same general courses. The courses consist of calculus, general physics, general chemistry, and general biology and environment.

Between 144-160 semester credits are needed for a S1 degree, the BS Team recommends 144 but most LPTKs take around 150-154 semester credits. The following table gives general descriptions of the curriculum for each of the four fields of study. The unit is semester credit.

<table>
<thead>
<tr>
<th>General courses</th>
<th>Semester Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 Science and Mathematics (including 24-28 semester credits for the First Common Year)</td>
<td>95-104</td>
</tr>
<tr>
<td>Educational theory, teaching and learning courses</td>
<td>28-35</td>
</tr>
<tr>
<td>Subjects to be determined at the local LPTK</td>
<td>6</td>
</tr>
</tbody>
</table>

We invited criticisms from several concerned groups, visited 10 IKIPs for the same purpose and then invited representatives of all LPTKs. After some modifications all LPTKs accepted the proposed curricula and then the DGHE made them official.

It is worth mentioning that in each core-curriculum, the BS Team appended also a complete curriculum as an example or reference. Every LPTK was supposed to write its own curriculum using the core-curriculum as a guideline. This approach, however, was entirely new. The BS Team persuaded the Director General of Higher Education to accept this approach. The previous curriculum committees stressed uniformity and produced ready-for-use curricula. However, one year later, to our dismay, the BS Team discovered that almost all LPTKs adopted the example.

**Staff Upgrading**

The BS Team soon discovered that most of the staff of LPTKs were not able to teach the science and mathematics courses in the new curricula. More than 75% of the academic staff were only S1 (B.A.) graduates where inbreeding was a common practice of recruitment. Thus upgrading the academic staff was imperative if the new curriculum had to be implemented. The BS Team persuaded two of the top universities in the country, ITB and UGM, to do the training. The training was only in subject matter and each lasted for three months. It was organized per course of the new curriculum. For example, LPTK calculus lecturers would study with ITB calculus lecturers, the former usually were also requested to attend ITB calculus lecture. By the end of 1994 about 2100, that is about 64% of all science and mathematics teacher educators of LPTKs, had been trained. About 830 young staff of LPTKs have been sent to one-year Pre-S2 Programs at ITB and UGM and about 65% of them managed to be accepted into S2 programs, of which about 90% managed to graduate. Some of them continued to S3 (Ph.D.) programs. In addition the BS Team has sent 110 senior staff of LPTKs for a three-month visit to overseas institutions to study mathematics and science teaching.
Textbooks and Lab Equipment.

Textbooks are just not available in many parts of the country and when available they almost are in English. Very few of the academic staff of LPTKs can make use of them, let alone LPTK students.

The BS Team has commissioned several scientists to write textbooks in the Indonesian language. The first draft of the books (17) are now being field tested and are expected to be published next year. Several textbooks have been translated from English to the Indonesian language. A complete list of needed lab equipment for all LPTKs has been forwarded to the DGHE to be purchased. About 100 lab technicians have been trained and many more will be trained in the near future.

Future Programs

The long term goal which the project eventually would like to pursue is the improvement of teaching-learning processes and outcomes in secondary school mathematics and science. This, in turn, necessitates the improvement in the quality of the prospective science and mathematics teachers produced by the LPTKs, and this becomes the intermediate target that the project would like to attain. The BS Team has managed to instill self-confidence in many academic staff of LPTKs. When they returned from training at ITB or UGM they brought home with them textbooks and lecture-notes, linkages amongst the trainees and their former trainers at ITB and UGM have been created. A national standard of academic qualifications of teacher educators in science and mathematics is expected to be achieved in the near future.

Problems and Programs in the Coming Years:

1. With regard to the new curriculum, there is a growing opinion that more emphasis should be given to pedagogical contents than the existing teacher education curriculum requires. In conjunction with the policy of curriculum flexibility, educator and administrators tend to suggest that all LPTK graduates should be able to teach two high school subjects, while subject matter specialists, especially those of mathematics and science, insist that it is difficult to prepare teachers with good content mastery to teach more than one subject. Furthermore, in the light of the 1994 curriculum for Junior Secondary School (SMP), there has been no clear policy on types and number of mathematics and science teachers required for SMP. Enrollments are expected to increase due to the introduction of compulsory junior secondary education. However, the zero growth policy for the number of civil servants creates uncertainty about the number of teachers that can be appointed.

2. In conjunction with curriculum implementation, there is strong evidence regarding the insufficient quality of instruction occurring in some LPTKs due to their lack of qualified staff. Staff accepted in the pre-S2 programs are unevenly distributed. They mostly come from LPTKs in Java while of those that come from further away only a few can pass the pre-S2 entrance tests. Besides, due to the slow process of facilities and equipment provisions, at present, there is a considerable number of LPTKs which do not have sufficient textbooks and facilities/equipment to support the implementation of the new curriculum. In addition to that, most of the LPTKs suffer from lack of qualified laboratory workers and technicians required to manage and support labs and workshop activities.

3. Revision/development of LPTK curricula for preparing junior secondary mathematics and science teachers.

4. Monitoring and evaluation of curriculum implementation in various LPTKs.

5. As many as possible academic staff of LPTKs should be encouraged to take graduate programs, either in subject matter or teaching. Crash programs such as short-term training in science and mathematics, lab. instructors, and lab technicians will be continued.

6. In spite of the large quantity of research on teaching mathematics and science that has been undertaken, these researches do not seem to have been well planned and implemented by the staff. Besides, almost none of the staff have any experience in conducting research in science and mathematics. More academic-staff should be sent broad to study research on teaching.

7. The BS Team is currently preparing five IKIPs to become growth centres which, after being further strengthened, will assist other LPTKs to improve their own programs. Two of the centres will have graduate programs in science and mathematics education in the future.

References


THE STRUCTURAL ATTRIBUTES OF ANIMALS
COMMENTED UPON BY PRIMARY SCHOOL CHILDREN AT THE ZOO

Sue Dale Tunnicliffe
Formerly Head of Education Zoological Society of London

Zoologists use criterial attributes to identify animal specimens and allocate them to their appropriate taxonomic category. Do school children spontaneously notice the same attributes when they observe animals and do their teachers focus the children's attention on such features?

Natazde (1963) found that Russian Children, between seven and ten years, had difficulty in classifying common animals while Ryman (1974a) showed that twelve year old children studying biology could identify and provide an acceptable name for animals that they had been taught, but could not classify animals into a taxonomic group, suggesting that they had no grasp of the criterial attributes required to perform such a task. A number of studies have identified what attributes of animals children use as distinguishing features in classroom exercises (Lucas, Linke, & Sedgwick, 1979; Mintzes, 1989; Sherwood, 1986; Sherwood, Rallis, & Stone, 1989; Tamir & Sever, 1980; Trowbridge & Mintzes, 1985). Older primary children list locomotory; appendages, the body coverings and attributes associated with the front end of the animals as the distinguishing feature (Bell, 1981; Braund, 1991, Mintzes, Trowbridge, Arnaudin, & Wandrese 1991; Trowbridge & Mintzes, 1985; Trowbridge & Mintzes, 1988). Locomotory organs, i.e. limbs or wings, are the parts referred to most often by children, (Bell, 1981; Braund, 1991). Twelve year old school children cited head/limbs/body covering as critical attributes for identifying a vertebrate member (Ryman, 1974). However, do the children focus on locomotory organs, body coverings and the front end of the animal when they look at live animals? The purpose of the study reported in this paper was to find out about which parts of the bodies of live zoo animals children noticed and commented spontaneously.

School groups are ostensibly taken to the zoo to learn about a particular relevant topic from the curriculum (Marshdoyle, Bowman, & Mullins, 1982; Tunnicliffe, 1994). Criterial attributes of the major taxonomic groups are a focus of many primary/elementary curricula, for example the English and Welsh National Curriculum in Science (DES, 1991), which is organised in ten levels, which children begin to study in the academic year in which they are six years old, requires that at Level 2, 'pupils should be able to sort familiar living things into broad groups according to easily observed features'. Level 3 states that children should:

- know the basic life processes common to humans and other animals.
- know that human activity in the environment can affect changes in plants and animals.'

At Level 4 children should:

- be able to assign plants and animals to their major group using observable features, through first hand observation.'

However, the content of the spontaneous conversations of primary school children and their accompanying adults was unknown.

The type of conversations heard were short. The following conversation between seven year olds, at the Bearded Lizards in the Reptile House at London Zoo, is typical of the exchanges that occur within school groups.

Boy: 'There’s one and there’s one and there’s one!
Boy 2: 'See that buffalo skull over there? That’s from America and there’s a light bulb too!
Teacher: 'Can you see the animals clearly?
Boy: 'No! They blend in.
Teacher: 'What do you call that?
Boy: 'Camouflage!

I needed to find a method by which I could capture the spontaneous conversations and then analyze these exchanges for their content.

Method

The results presented in this paper are part of a large study in which broad categories of topics of conversations became apparent. The comments about the parts of the animal’s body were identified using a systemic network (Bliss, Ogborn, & Monk, 1983; Tunnicliffe, 1993).

There were 74 categories in the network. The parts concerning structures of the body are shown in Figure 1.
A bracket, '[]', indicates one of a number of categories which an animal may have. Each conversation unit was categorised with the appropriate number from the networks. Hence the above conversation, at the Beaded Lizards, was represented in the following way.

Boy: There's one and there's one and there's one
50/ 74/ 55/ 18/ 40/

Boy two: See that buffalo skull over there? That's 20/ 16/ 17 from America and there's a light bulb too'
13/ 69/ 23

Teacher: Can you see the animals clearly?
3/ 20/ 31

Boy: No they blend in!
13

Teacher: What do you call that?
31

Boy: Camouflage!

The teacher in charge of each school party was approached and permission requested from them to record the conversations of the children and their accompanying adult. Following the visit the tapes were transcribed, coded and entered into a worksheet of Minitab (Minitab, 1991).

Conversations were recorded wherever the groups went. The majority of the conversations were at vertebrates, in particular mammals reptiles or birds.

Discussion

The content of the conversations reveals that these visitors notice predominantly the dimensions of the animal (size, shape, body covering). When a feature was obvious, or was drawn to the attention of the visitor through unusual behaviour in front of the visitor, it was commented about, e.g. excretory organs. Unexpectedly, there does not appear to be an active seeking out and mentioning of particular parts of the anatomy of the animals.

The psychological research of (Tversky, 1985) shows that the shape and colour of objects are the dimensions preferred by young children when they group inanimate objects so it should not be surprising that it is this type of attribute children notice about the animals. Furthermore, Tversky (1989) showed that children notice the salient parts of objects first of all, hence the shape, the head, the legs and the tail, are the most salient features of animals and are those that children notice.

The data from this study provides a base line upon which zoos and their education departments can construct meaningful interpretation within the zoo and for the school visitors before and after their visit. The results suggest the visitors do not embark knowing nothing of animals but use their everyday
knowledge and experiences in interpreting the exhibits.

Primary school groups embark upon their visit with an everyday knowledge and vocabulary about animals which they apply to the specimens which they view in the zoo. The dimensions of the animal form the largest category of observational comments followed by remarks associated with the front end of the body. It is not surprising because human beings seek eye contact and usually look at the face of the human to whom they are communicating and it seems likely this habit of seeking the face is carried into the observations the children and their accompanying adults make when observing animals.

Trowbridge and Mintzes (1985) reflect that 
'. . . students consider ambiguous and often conflicting pieces of information when classifying animals, ultimately arriving at a decision based on relative size or perceived importance of body parts.' Furthermore, Mintzes, Trowbridge, Arnaudin and Wandersee, (1991), suggest that children would be taught classification most effectively by the teachers using live or preserved specimens and offering immediate feedback to their pupils. The visit to the zoo provides an opportunity to do just this. The teachers can help the children learn the criterial attributes for the major taxonomic groups that children are expected to know and understand by using the children's tendencies to notice particular attributes. These first hand observations can be developed so that the children recognise and using the key features used in the taxonomy of the animals viewed and the main groups to which they belong such as mammal or reptile, cats or snakes.

This data suggests that the children and their teachers, and the educational material provided by the zoos do not take the opportunity of a visit to live animals to develop the children's knowledge of the features necessary for practicing taxonomy.

This study shows that groups of primary school children do not focus spontaneously on critical attributes that are required by zoologists in classifying animals. However, there are certain features that the children and their accompanying adults do notice and these could be used as the basis of developing the knowledge about taxonomic classification required for science courses.

References


April 7-11, 1995
**Science Education Research in Europe**
Location: The University of Leeds, UK
Organised jointly by The Centre for Educational Studies, King’s College, University of London and The Centre for Studies in Science and Mathematics Education, The University of Leeds
**Contact:** Thelma Wightman, Conference Secretary, Centre for Studies in Science and Mathematics Education, University of Leeds, LEEDS LS2 9JT, United Kingdom. Fax: 0532-334683 by November 30, 1994.

April 22-25, 1995
**NARST International Conference**
Location: San Francisco, CA, USA

June 5-12, 1995
**Symposium IV: Population, Education & Culture Session 21. Scientific and Technological Literacy for All**
Location: Beijing International Convention Center
Beijing, China

June 10-14, 1995
**Innovations 2020**
Third International Symposium on Technician Education and Training
**Contact:** Innovations 2020
Third International Symposium on Technician Education and Training
10767 148th Street
Surrey, B.C.
Canada V3R 0S4
Tel: (604) 585-2788 Fax: (604) 585-2790

July 1995
**NSTA National Conference**
Jamaica

July 9-14, 1995
Location: Johannesburg College of Education
Johannesburg, South Africa
Organised by the STEME (Science, Technology, Environmental & Mathematics Education Association) on behalf of the Federation of Science & Mathematics Teachers.
**Contact:** Lesley Stephenson, Conference Office
PO Box 327, Wits 2050, South Africa

August 27th-September 1st, 1995
**Partners in Chemical Education**
**An International Conference on Industry-Education Initiatives in Chemistry**
Location: University of York, York, UK
**Contact:** Miranda Mapleton
Chemical Industry Education Centre, Department of Chemistry, University of York, York, YO1 5DD, UK
Co-Sponsors: International Union of Pure and Applied Chemistry (Committee on Teaching of Chemistry) and Royal Society of Chemistry (Education Division and Industrial Division)

August 29th–September 2nd, 1995
**The International Conference on Industry – Education Initiatives in Chemistry**
Location: University of York, York, UK
Organisers: IUPAC Committee on Teaching of Chemistry
The Royal Society of Chemistry, University of York
The first major international conference sponsored by IUPAC which specifically aims to promote links and dialogue between concerned industrialists and teachers from higher education, secondary and primary schools, and educational decision makers; and to evaluate and encourage good practice and discuss issues of industry – education collaboration. Correspondence/Conference arrangements:
Dr. J. F. Gibson, The Royal Society of Chemistry
Burlington House, Piccadilly London W1V OBN, UK
Tel: +(44) (0) 71-437-8656
Fax: +(44) (0) 71-734-12275

September 4-15, 1995
**Fourth World Conference on Women**
Location: Beijing, China
**Contact:** Conference Secretariat: Division for the Advancement of Women, PO Box 500, A-1400
Vienna, Austria Tel: 431/21131, Ext. 4270;
Fax: 431/237-495 Media: Department of Public Information United Nations, Room S-1040 Tel: 212/963-1262; Fax: 212/963-4556
This conference will:
1) review and appraise the advancement of women since 1985 in terms of the objectives of the Nairobi Forward-looking Strategies for the
Advancement of Women to the Year 2000.

2) mobilize women and men at both the policy-making and grass-roots levels to achieve those objectives.

3) adopt a “Platform for Action,” concentrating on some of the key issues identified as representing a fundamental obstacle to the advancement of the majority of women in the world. It will include elements relating to awareness-raising, decision-making, literacy, poverty, health, violence, national machinery, refugees and technology.

4) determine the priorities to be followed in 1996-2001 for implementation of the Strategies within the United Nations system.

September 24-29, 1995
CONASTA 44
Location: University of Queensland, Brisbane, Queensland, Australia
Contact: David Tulip, Centre for Mathematics and Science Education, Locked Bag No. 2, Red Hill, Queensland, Australia. E-mail: D.Tulip@qut.edu.au
Tel: +64 7 864 3345 or Fax: +64 7 864 3985.
While the conference program is not finalised at this stage, it is envisaged that it will include theme lectures, symposia based on science education and workshops either based on current science research or science classroom practices. All symposia and workshop sessions will allow for personal choice and will cater for Primary, Secondary and Tertiary science teachers and science teacher educators. Educational tours of the Great Barrier Reef, tropical and subtropical rainforest, whale watching and other unique geographical and biological features of Queensland, will also be offered three to seven days prior to or immediately following the conference.

September 25-29, 1995
3rd European Conference on Research in Chemical Education
Location: Lublin (Poland)
Contact: Department of Chemical Education, Maria Curie-Sklodowska University, PL-M.C. Sklodowskiej 3, 20-031 Lublin, Poland.
Tel: (81) 37-56-91 Fax: (81) 336-91 e-mail: JANIUK@PLUMCS1
The previous two conferences were held in Montpelier, France in 1992 and in Pisa, Italy in 1993. The next conferences are planned to be held every two years. The conference in 1997 will be held probably in UK. The organizers of the conference are the Federation of European Chemical Societies and the Chemical Society of the country in which the conference is held.

December 1995-March 1996
CENAMEC
Venezuela
More detail to come

1996

Industry-Education (ELF Sponsored)
Location: Paris
More details to come

January 5-10, 1996
GASAT 8 International Conference
Location: Ahmedabad, Gujarat, India
Contact: Jayshree A Mehta
Conference Chair/Convener
GASAT 8 Secretariat
SATWAC Foundation
A1/22, Amrapali, Sukhipura, New Shardamandir Road, Paldi, Ahmedabad-380 007, INDIA
Tel: 91 79 428991, Fax: 91 79 416941

January 8-11, 1996
JISTEC '96
Location: Jerusalem, Israel
Contact: Conference Secretariat
P.O.B. 57005, Tel-Aviv 61570, Israel
Tel: (972) 3-61-33-340, Fax: (972) 3-61-33-341

February 7-9, 1996
International Consortium for Research in Science and Mathematics Education (ICRSME) 6th Consultation
Location: Belize City, Belize
Central America
Contact: Dr. Arthur L. White or Dr. Donna F. Berlin
The National Center for Science Teaching and Learning (NCSTL)
Room 100
Ohio State University
1929 Kenny Road
Columbus, OH 43210-1015 USA
Tel: (614) 292-3339, Fax: (614) 292-1595
March 28-31, 1996

NSTA National Conference
Location: St. Louis, MO, USA
May 28-31, 1996
14th Dortmund Summer Symposium
Theme: Educational Research in Chemistry and Physics Education
Contact: Dr. Hans-Jürgen Schmidt
University of Dortmund, Dept. of Chemistry
Otto-Hahn-Str. 6
43221 Dortmund
Germany
The main aim of this conference is to discuss the methodology of empirical research in this field.

June 1996
First World International Congress of Science Centres
Location: Finland
More details to come

July 14-19, 1996
14th International Conference on Chemical Education
Location: Brisbane, Australia
Contact: The ICCE Conference Secretariat
(Sally Brown), Continuing Professional Education,
The University of Queensland 4072 Australia
Tel: (07) 365 6360 Intl: +61 7 365 6360
Fax: (07) 365 7099 Intl: +61 7 365 7099
E-mail: chemed96@ceu.uq.oz.au
The 14th ICCE will be held in Brisbane from July 14-19, 1996. It is only the second time this conference has been held in the southern hemisphere. The biennial conference brings together chemistry teachers, chemists and science educators from school, industry and university settings to share ideas and learn from one another about innovation in teaching and learning and the discipline of chemistry. The theme, Chemistry: Expanding the Boundaries, acknowledges the centrality of chemistry through its expanding relationship with many facets of science and everyday life. Conference participants will be challenged to develop this theme with the view of enhancing our understanding of the important relationships which chemistry forms with the new frontiers of human endeavour. Implications for chemical education beyond 2000 which give a “science for all” perspective will be encouraged.

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Extending and Improving Education in Science for All Children and Youth by Assisting Member Association Throughout the World

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Science Education International is the Quarterly Journal of the International Council of Associations for Science Education. ICASE was established in 1973 to extend and improve education in science for all children and youth by assisting member associations throughout the world.

This journal provides a means for associations, institutions, centres, foundations, companies and individuals concerned with science education, to share perspectives, concerns, ideas, and information which will foster cooperative efforts to improve science education, and which will serve as a chronicle of the advancement of science education throughout the world.

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ICASE News
Tribute to Sheila Haggis 2
European Chemical Industry Council (CEFIC) Joins ICASE 2
ICASE Stepping into Science and the Greek Pupils' Presentation 3
Challenges to Science Teacher Associations 4
Educational Science Centre is Under the Supervision of Non-Formal Education Department, the Ministry of Education 6

Feature Article
Science Across Europe, Then the World 7
Nurturing the Child's Ecological Mind: A Proposed Model Beyond STS 8
Microcosmos: An Internationally-Oriented Team-Based Model for Science Education Reform 11

Science Education Around the World
Hethersett Old Hall Link with Wulugu, Northern Ghana 15
A Science Education Center at Universidad de los Andes 16
Japanese STS Initiatives 19

Research on Curriculum, Teaching & Learning
From Object, Through Word to Understanding: Language Development Through Science Activity 22

Teaching Materials & Strategies
Primary Science Education in Greece 24

Science Teacher Education & Leadership
AIDS is No Game: An Interactive Role Play 27

Non-formal & Informal Science Education
Learning to Teach and the Science Museum 31

Resources
Recent ICASE Publications 35
Calendar 37
TRIBUTE TO SHEILA HAGGIS

The “mother” of ICASE died in Paris on 5 April 1995.

The name Sheila Haggis is synonymous with science education worldwide. Her work in UNESCO Paris as Head of the Science Education Section, and latterly as a consultant to UNESCO, brought her into contact with literally hundreds, and perhaps thousands, of science educators, including science teachers throughout the world.

But, it is with science teachers’ associations that we, in ICASE, will best remember her. She was instrumental in the setting up of the Ghana Science Teachers’ Association (GAST) in the 1960s, whilst she was a science teacher in that country. Then, when she joined UNESCO in the late 1960s she worked hard to support the development of science teachers’ associations. With UNESCO support Sheila convened a regional meeting of representatives of science teachers’ associations in Asia in 1972, which prepared the way for the establishment of ICASE in April 1973 at a meeting in Maryland, USA. Her guidance during this inaugural meeting endeared her to all who were the founder members of ICASE; hence she was affectionately known as the “mother” of ICASE.

For the 20+ years since that time Sheila strongly supported the work of ICASE and provided, on many occasions, invaluable advice on strategy and development programmes for ICASE. She was, for instance, instrumental in supporting an important international conference on integrated science held under ICASE auspices in Nijmegen, Netherlands in 1978. And, more recently, in helping ICASE and UNESCO to launch Project 2000+ on scientific and technological literacy.

Much can be written about Sheila Haggis as a teacher and author of science books for students, her ability as an administrator of international education programmes through the UN organisation, UNESCO, and her gift for writing clear reports and proposals for international organisations. Much, also, could be written to describe Sheila as a charming and elegant lady who conducted her professional and private life with dignity and with understanding of the needs of others. And, all of us who knew Sheila will have special memories of speeches, lectures, committee meetings, working groups, and social occasions at which we have been privileged to listen to or meet her. Certainly, we, in the ICASE family, deeply mourn the loss of an outstanding figurehead in the international science education community - a person whom we honoured with the ICASE Distinguished Service to Science Education Award in 1989.

EUROPEAN CHEMICAL INDUSTRY COUNCIL (CEFIC) JOINS ICASE

CEFIC has become an institutional member of ICASE. The correspondent is Dr. David Bricknell. A copy of the proceedings from the November 1994 CEFIC-ICASE Conference can be obtained from Dr. Bricknell at the following address.

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Av. E. van Niewenhuyse 4
B-1160
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Tel: (32) 2 676 7211
Fax: (32) 2 676 7300
ICASE STEPPING INTO SCIENCE AND THE GREEK PUPILS’ PRESENTATION

Dr. Zoe Zoni Kavogi
Greek School of London

Participants enjoyed all the activities shared at the popular ICASE Come and Share session at the January 1995 ASE Annual Meeting at the University of Lancaster. Pupils from the Greek School of London presented activities entitled “Science Recipes from Greece” to science teachers. Teachers also had a hands-on experience with them. These activities were events from a science project which is in progress in the Greek School of London. The project is entitled “Stepping into Science in the Form of Discrepant Events” and is carried out by Dr. Zoe Zoni Kavogi.

In this session, pupils introduced to teachers an alternative way of teaching physics, as some participants claimed that “these activities were thought-provoking,” “these were minds-on and hands-on activities,” and “they stimulated curiosity and motivation to comprehend the science topics.” Among the participants who shared the Greek pupils’ activities were Mrs. Sue Dale Tunicliffe, Section Editor of the ICASE Science International Journal and Mrs. Anna Garner, President Elect, ICASE and Representative of Iceland.

Pupils would welcome an opportunity to share their activities. Do not hesitate to contact:

Dr. Zoe Zoni Kavogi
Greek School of London
3 Pierrepont Road
Action, London W#
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0181-568 7511

“Oxygen in the Air.” Can you make the coloured water rise in the jar and come alive?
CHALLENGES TO SCIENCE TEACHER ASSOCIATIONS

Mary Ratcliffe
School of Education
University of Southampton

The roles of science teacher associations in the relationships between “researchers” and “practitioners” was a focus for an international gathering under the auspices of ICASE and ASE. Sixty-five educators, many representing their country’s science education association, met for a day prior to the ASE 1995 annual meeting to consider the relationship between research and practice.

Four keynote speakers set the scene by outlining a particular perspective on education research and classroom practice relationships. John Penick, from the University of Iowa, illustrated how established research findings can have a positive or negative impact in the classroom depending on the attention given by teachers. A research finding which he considers most important is “students copy their teachers’ behavioral patterns.” He stressed the importance of self-evaluation by teachers (and researchers) in promoting active learning.

Dissemination of research outcomes was discussed by Maria Saez from the University of Valladolid, Spain. She highlighted some key features which may assist dissemination.

- Decide the method of dissemination at the outset of research and actively involve practitioners in the planning for dissemination.
- Use case studies which are based on qualitative, holistic methodologies.

Many teachers are pragmatic in their approach to teaching and do not seek a theoretical stance to inform their practice. This was a view proposed by Jonathan Osborne from King’s College, London. He argued that classroom-based research, involving teachers in both implementation and dissemination, can promote the use of active learning strategies.

The perspective of the classroom practitioner was represented by Adrian Pickles, an experienced English science teacher. He explained the difficulties of making use of research findings even among those willing and able to access these. He highlighted his own experience in using some research publications and in the lack of positive action by colleagues. Lack of time, coping with curriculum change, and lack of mechanisms for active dialogue between researchers and teachers can all contribute to resistance to reflection on and change in classroom practice.

These presentations set the scene for active discussion involving all participants.

Participants were anxious to change this relationship between researchers and practitioners. As researchers and teachers, we must:

- plan, implement and disseminate research in collaboration.
- listen to each other’s perspectives and problems.
- produce readable, well-publicised articles which have direct classroom relevance.
- use multidisciplinary approaches and involve a wide range of people with differing expertise.
- view our joint relationship as important in preservice and through continuing professional development.

Role of Associations

Participants concluded that there were important roles for science education associations in assisting the development of this positive relationship. Participants were keen to see these acted upon. Science education associations should:

- develop explicit policies and structures which recognise the diversity of the association’s membership and which enable a constructive dialogue to take place.
- publish, in an accessible form, short, readable articles which have direct meaning and impact for science teachers. This should include all types of relevant research.
- deliberately organise meetings in which teachers and researchers can discuss research issues.
- plan and disseminate research and support research-based initiatives in preservice and inservice training.

The discussions also raised a number of issues, which were left unaddressed:

- What of policy makers in this relationship?
- More active involvement in the relationship outlines would be beneficial?
- What counts as research and who undertakes it?
- How do those involved in examination, curriculum development and assessment, and the educational media fit into this relationship?
- What are the implications for associations’ structures and procedures?

These unanswered questions should not be ignored. They should be part of an ongoing debate.
for action by associations. To quote from the outcomes of one discussion group, “Teachers are not necessarily resistant to change. They like well-informed, well-researched, timely and inspirational changes.”

Note: ICASE is very indebted to Mary for organising and chairing this meeting and wishes to express its sincere gratitude. ICASE hopes that readers will find much to consider in this report and be willing to contact ICASE giving reactions, concerns, and suggestions for their country in this important area. Science education research is growing at a fast pace, but so much of this is restricted to so few countries and published in journals that are expensive to purchase (even for libraries). How far is the transference of research findings applicable across country boundaries and how can research findings be made more accessible to the practitioners?

—Jack Holbrook, Executive Secretary, ICASE

Editorial Note: Member organisations are encouraged to reprint this or any other ICASE-SEI article.

MODEL 1 AN EXTREME PESSIMISTIC VIEW OF THE RELATIONSHIP

We decide the areas to be researched

RESEARCHER

We have the answers

We decide and organise dissemination

If you do as we say, learning will improve

PRACTITIONERS

We do not have time to reflect

We are not prepared to read long complex research reports

We do not wish to do your bidding

MODEL 2 A MORE CONSTRUCTIVE, DYNAMIC RELATIONSHIP WOULD ASSIST ALL CONCERNED.

MEMBERS OF SCIENCE

RESEARCHERS

PRACTITIONERS

EDUCATION ASSOCIATIONS

researchers are/can be teachers

teachers are/can be researchers
EDUCATIONAL SCIENCE CENTRE IS UNDER THE SUPERVISION OF NON-FORMAL EDUCATION DEPARTMENT, THE MINISTRY OF EDUCATION

Dr. Kla Somtrakool
Educational Science Centre
Bangkok, THAILAND

Educational Science Centre, Bangkok is a new name in the global science centre community. Nevertheless, they have been providing science education via exhibitions and educational activities since 1980. It is aimed at promoting the awareness and the role of science and technology among the youth and the public in the fast growing society of Thailand.

Until late 1994 the organization was called Centre for Educational Museums, but has since been changed to Educational Science Centre. This is a part of the national project on Educational Science Centre and its Network to acknowledge the increasing importance of science and technology in the development of the country. And auspiciously, it is to celebrate the Golden Jubilee of His Majesty the King’s Accession to the throne in 1995.

In addition to the primary Educational Science Centre at the Ekamai site a new campus will be established at Rangsit, the northern outskirt of Bangkok. In addition, 76 Provincial Educational Science Centres will be established in all provinces throughout the country within the next 5-7 years. To name a few remarkable centres nearing completion: The King Mongkut Memorial Park of Science and Technology at Wa Koh, Prachuap Khiri Khan province will be completed in 1997; and the pilot project at Nakornsritammarat ang Trang Provincial Educational Science Centres just recently opened.

A wide range of educational activities and services are offered to school children and the public the whole year round. It also plans to cooperate with the science centres around the world in the exchange of ideas and personnel, including exhibitions.

Contact: Dr. Kla Somtrakool, Director, Educational Science Centre, 928 Sukhumvit Road, Klong-Toey, Bangkok 10110, THAILAND.
Tel: 662 3925960; Fax: 662-3910522

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8TH INTERNATIONAL ORGANIZATION OF SCIENCE AND TECHNOLOGY EDUCATION (IOSTE) SYMPOSIUM
EDMONTON, ALBERTA, CANADA

Alberta Education will be hosting hundreds of international participants at the 8th International Organization for Science and Technology Education (IOSTE) Symposium in August 1996.

IOSTE is an organization committed to advancing the cause of science and technology education as a vital part of the general education of all people in all countries of the world. As well, IOSTE identifies the changing science and technology education needs of humankind and nations. The members of IOSTE are approximately 600 science and technology education policy and decision makers in regions that include the Arab States, Australia and Oceania, South and East Asia, Africa, North and South America, and Eastern and Western Europe.

The symposium’s theme is Science and Technology Education for Responsible Citizenship and Economic Development: Evidence, Policy and Practices. The theme also addresses two emerging demands of science and technology education worldwide; preparing students to:

- make appropriate decisions regarding local and global environmental issues, and make wise use of natural resources.
- contribute toward responsible economic development in a highly competitive and integrated global economy.

Inquiries and calls for proposal forms can be directed to:

Raja Panwar
8th IOSTE Symposium, Curriculum Standards Branch, Alberta Education
Devonian Building, West Tower, 11160 Jasper Avenue
Edmonton, Alberta Canada T5K0L2
Telephone: (403) 427-2984 Fax: (403) 422-3745 Internet: RPanwar@edc.gov.ab.ca
"The Earth is our common home. Let’s all look after it," is the message students from the Kosygin school in Arkhangelskoye (a village on the edge of Moscow), want to pass on to everyone involved in "Science across Europe."

This is just one of the many comments received at the headquarters of the Association for Science Education (ASE), home of the Science across Europe project. The project, which is a joint venture between ASE and British Petroleum (BP), was set up to introduce a European dimension into science education. The science curriculum provides common ground between schools in all the countries of Europe (and the world) and, thus, provides a forum in which students can exchange ideas and opinions about science-related issues.

Background
A grant from BP enabled ASE to set up a pilot project in 1990. A team of science teachers from six countries got together to plan two units: one on Acid Rain, the other on Energy Use. The basic idea is simple. Take a topic related to the science curriculum and get students in different countries to exchange information and opinions. Thus, in the Acid Rain unit, students from Britain learn from students in, say, Sweden or Switzerland, about the problems caused by acid rain in their country, asking who is to blame and, most importantly, what they think can and should be done about it.

Continuing support from BP has enabled the project to grow to the point that there are now six units in publication dealing with Drinking Water, Food, Renewable Energy and Global Warming, along with Acid Rain and Energy Use covered in the two original units. At first, each unit was translated into 10 languages, but the project is presently expanding to include more languages such as Russian and Greek. Schools all over Europe can purchase the books.

Participation
There is currently a network of schools in more than 20 European countries involved in the project. Details of each school taking part are held on a computerized database. Each participating school receives a list of all the other schools around Europe that are also using that unit. They can then select one or more schools from the list with which to exchange information. The information exchange can take place by mail, fax, or e-mail.

Opportunities for Cross-curricular Work and Cultural Exchanges
Clearly, the project is not limited to science. There are many opportunities to include economics, languages, geography and social science.

As students receive information about a topic from schools in other countries, they also begin to learn about the cultural similarities and differences that exist from country to country. For example, information received from students in France working on the Food unit suggests that between meal snacks such as crisps and chocolate are rarely eaten in their country.

Indeed, once received, the uses to which the information can be put are endless. One school in Slovenia has used the Using Energy at Home unit to make a cross-curricular study which lasted several weeks and included English, technology and geography, as well as science. Moreover, schools are not limited to the schools listed on the database for their information exchange. A British school used the Acid Rain unit as the basis for a residential week shared with their existing partner schools across Europe. Students from other countries arrived armed with the results of their work on acid rain.

The Drinking Water unit led the Kosygin school, near Moscow, to seek external information for the first time. At first, the water authority of ficials were most surprised by the students asking questions, but, after persistent efforts, they obtained the details they wanted. The results led to follow-up work on environmental pollution and water quality and also raised the issue that water was not a free commodity. This led them to think about some of the costs and benefits regarding economic development and the environment.

Industry/Education Partnership
The involvement of BP has been crucial in the development of the project, not only from the
viewpoint of funding, but also because the company’s presence in most European countries has provided additional links to ASE’s existing network of members across the continent. BP’s activities in countries beyond Europe have enabled the project to develop a network in the Asia Pacific region involving around 300 schools from Indonesia, Malaysia, Singapore, Thailand, New Zealand and Australia. During 1995, this network will expand to include Korea, Brunei Darussalam and Japan. In addition, a small group of schools in the USA has joined the project, supported by Community and Educational Relations staff at BP’s Cleveland, Ohio site. Now, a new network is planned for Africa. These new networks will provide even greater opportunities for information exchange between students as Science Across Europe becomes part of a global network, Science Across the World.

If you would like more information about Science Across Europe and the World, please contact: Evelyn Van Dyk, ASE, College Lane, Hatfield, AL10 9AA, UK Fax: +44 (0)707 266532

Two students from Stanborough School, UK, test the acidity of rain water

ICASE

NURTURING THE CHILD’S ECOLOGICAL MIND: A PROPOSED MODEL BEYOND STS

Kat Hudson, Ruamrudee International School
John Stiles, University of Northern Iowa

Looking over our notes from the ICASE Asian Symposium in Bangkok in December, one term kept recurring: sustainable development. Speakers repeatedly trotted out this “buzz word” as they called again and again for educational curricula to incorporate the STS (Science Technology Society) or STL (Science and Technology Literacy) models, so that we may teach students how science and technology must move toward a global perspective of sustainable development.

Science educators with various points of view and from diverse cultures and nations gathered to share ideas in environmental education with the goal of helping to reach an economic and ecological balance to preserve natural resources and further human development. The idea which seemed central to the theme was that educators must teach students how technology can help correct the ecological disasters which humans have caused. In other words,
technology has played a major role in creating large-scale environmental problems since the advent of the industrial revolution, and society must now use current technology to stop this trend and/or heal the scars.

We question the use of technology as a tool to move toward “development” if it is purely economic in nature. The quality of human life is not always improved or “developed” because of technology. Science and technology void of ecological consciousness and without regard for interdependence of organisms and their environment will result in long-term disaster. In addition, without this ecological consciousness, the human spirit of every individual is weakened.

Many at the ICASE Symposium suggested that environmental education issues should be studied after ecological disasters have occurred, and then teaching what should be done to correct the problem. However, we suggest that it is more reasonable and effective to strengthen the innate ecological mind in children before introducing issues in STS or STL.

The STS message is that the power to heal the earth comes from technology and the responsibility of decision-making in the wise use of that technology. However, this does not empower students enough to believe that the individual has the ability to make wise decisions based on a personal relationship which is developed between them and nature. This process is developmental, beginning with the individual, exploring the self (sensory), then his/her environment and finally the child’s societal position. Educators rarely provide students opportunity to explore that connection to nature. Not only are students isolated from the environment (sequestered in a classroom) in order to occasionally—if ever—teach about it, but we do it through use of technology! Decision making is based on group actions in response to some technological issue. Rarely is there the opportunity to first develop a sense of stewardship on which to base environmentally sound decisions.

We can develop technology that is motivated by an environmental focus, rather than the reverse, which is what occurs in our society now. The result will be an environmental technology consciousness which is individually based and which blossoms into a societal pursuit. Thus, by strengthening the human bond with nature, and then introducing the role of science and technology, the investment in conservation and environmental education is many times greater for future generations.

Economic growth based on ecological considerations is the only way to create long-term sustainable development, if indeed sustainable development is possible. If it is based on anything else, there can be only ecological failure. It is apparent that the “top down” bureaucratic approach to problem-solving is ineffective. It is idealistic to call for cooperation between societal sectors, but we believe that it will only be through education that this ecologically-centered vehicle will be able to affect long-term change based on environmental consciousness. We need action, not mottoes or political rhetoric. Therefore, education of and by our teachers is key.

We propose a new model based on development of the child’s ecological mind, thus moving beyond STS to EMST (Environmentally Motivated Science and Technology). This model is based on the following premises:

Premise 1: We are all born with an ecological mind which governs interactions with our environment. Primarily, these interactions are through the senses, allowing the individual to act in a basic, sustainable way in order to survive.

Premise 2: All children have a natural sense of curiosity and unrefined observation skills. As the child grows and is introduced to aspects of our technological world, s/he uses these skills less and less, and loses touch with the natural environment.

Premise 3: Institutionalized education removes the child from his/her natural environment. The result is that the ecological mind is stifled, and students are introduced to the idea that technology is the primary means by which environmental problems can be addressed. An analogy would be one in which a person is put on a boat and asked to understand what the ocean is without ever having learned to swim in it.

A Proposed Model to Nurture the Child’s Ecological Mind

In the primary grades (ages 5-8), environmental education should be central to the curriculum, providing ample opportunity for students to individually explore nature in the natural environment. This developmental approach is appropriate for the primary years, allowing children to develop their own ecological understanding, and at their own individual rates. The teacher’s role is to enthusiastically reserve time, perhaps in an interdisciplinary approach, for activities which give children time alone in nature.
The students must be encouraged to express their ideas and feelings and describe experiences which are not evaluated, and which build unique ways of looking at the natural world. The focus is on children learning that nature is not separate from them, but that they are part of it.

At this age, children should be given many ongoing opportunities to role play in order to gain a perspective of various components of the natural world. For example, young children love pretending to be plants or animals or wind, moving their bodies to perceived natural rhythms, thus developing an awareness and sensitivity to those particular members of nature.

During the upper elementary years (ages 9-12), children may learn about consequences (cause and effect) from an individual point of view based on their developing environmental consciousness ("My actions cause this."). Students learn that there are choices, and certain responsible actions can be practiced at the individual level which promote a healthier environment. This type of opportunity is often lacking in education, where decision-making is now done almost entirely by groups.

The use of technology and science equipment may be introduced as assisting us in the decision-making. It should be noted that they are tools only, not the answer (or primary force) themselves. Children learn that the true power lies in the individual’s ecological mind and its ability to reason, and to act responsibly for the self, as well as for society. All this is done through an environmental focus.

In the middle school (ages 13-15), students continue direct exploration of the natural world, spending time in nature in different natural settings at various times of the year. This also helps them distinguish and explore their changing maturity and how their relationship with nature is affected.

This is an appropriate time to develop the group decision-making process through simulated problem-solving and awareness of environmental issues. Local guest speakers may be invited to visit the class and discuss current concerns which directly affect the students. Students learn that they can affect the decisions made by others.

In high school (ages 16-18), introduction of the role of government and ways it implements policy builds upon the foundations laid in the earlier years. Students do not simply role play: they take action at the school or community level, involved in resolving some local environmental issue of their choice. This type of application must be supported by the community and local government. Expanding to more regional or global issues may take place once students act locally.

Technology continues to be emphasized as an effective tool for examining current environmental problems and correcting past mistakes, and perhaps most importantly, predicting and thus preventing future environmental disasters.

As a result of this approach, high school graduates do not just enter the adult world with knowledge of the environment, but understanding that it is a part of them, and that they have the power to affect change. The schools thus produce competent, confident citizens, aware of their entire development from a historical perspective. They can then continue to teach others by example, particularly their own children, thus creating a type of cultural wisdom handed down generation by generation, such as those traditions integral to most “primitive” societies.

Schools must develop this environmentally centered model as an integrated approach which all teachers and administrators support. The model is sequential, but also revisits and strengthens skills and concepts, and nurtures attitudes of environmental concern as students progress through school. It cannot be the primary responsibility of any one person or subject area if it is to succeed as being a frame of mind by which one makes decisions. It must be reinforced at all levels and in all disciplines.

The environment may be thought of as connected to the human spirit or soul, just as it is connected to everything else. This is evident in spiritual teachings and cultural histories of almost every non-industrialized society. It is no accident that industrialized and “developing” nations, which base their economies on technology and economic growth, show little—if any—environmental consciousness.

The ecological mind is simplicity: how to survive and exist among the resources available. We’ve moved further from the answers which lie within us, toward a technological substitute created by the human mind, not by the human spirit. STS is missing that spirit-mind connection.

There is a great sense of security and confidence when one knows that others are also thinking from an environmental perspective. If our society can move toward that environmentally motivated model, we will take giant strides toward elimination of what has been termed “eco-phobia” which so many children have in today’s society. It is this phobia which prevents one from taking responsible actions to protect the environment. The EMST model can give children the confidence to take action from a very early age, and as a result, have a well-developed ecological mind as they enter adult society.
MICROCOSMOS: AN INTERNATIONALLY-ORIENTED, TEAM-BASED MODEL FOR SCIENCE EDUCATION REFORM

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The most common and arguably the most influential life forms on the planet are precisely the ones which have been ignored the most in both history and education. The millions of organisms that together fit into areas no bigger than the period at the end of this sentence are not only crucial to earth systems (Schopf, 1992; Margulis & Sagan, 1993) but have played a key role in the evolution of a unique science education reform effort based in Boston, Microcosmos (Travis, 1992).

As citizens we all admire the antique hutch restorer, this artisan who busily scrapes away the layers of abused paint, who creates a sudden blizzard of flakes from the cringing sounds of a blade. As the surface breaks apart into so many million bits and pieces, a new wooden monument is gradually revealed. The dustbin collects the paint chips while this knotted resurrection stands front and center. In our search for understanding of ourselves and the planet, we as educators have not even remotely shared that all the surfaces of the globe are antique layers, vast communities of life like thick invisible paint. There is barely a surface that is bare of microorganisms! The Microcosmos science education program has been developing the right tools such that educators can both discover and peel away this surface. But the ever-reproducing “dust” scraped away is hardly discarded. Rather, it becomes a centerpiece, part of the resurrection of life science education and a model for science education reform.

Since its initiation in 1988, the Microcosmos program based at Boston University’s School of Education has focused on showing that life too small to be seen with the naked eye can be a vehicle for stimulating enthusiasm for science among students, as well as bringing us all closer to an understanding of how the earth works. Through these “inner space” classroom travels, the program’s first intent was to help fill a massive crater in science education with a blend of new life discovery and a revitalized emphasis on how to motivate and stimulate the vast numbers of pre-college classroom non-learners. More than 2500 teachers around the United States and another several hundred from New Zealand, Canada, Spain, and Denmark have been directly trained in the inquiry and constructivist-based pedagogy of Microcosmos. Many of these teachers have not only successfully integrated the explorations into their curricula, but have shared what they have learned through regional mini-workshops. They have become enthused and empowered. Through Microcosmos, they have discovered that important science educational reform can be built around a specialty subject area and expanded in various creative directions.

Microcosmos, as an internationally-founded project can teach us lessons about how to promulgate healthy science educational reform. The program’s evolution suggests that building systemic change for science improvement may depend in large part on how teacher training and curriculum development efforts are socially structured and maintained. What are the components that we need to value in science education reform that are inherent in Microcosmos? *Microcosmos evolved through a team concept.*

Approximately 20 individuals at any given time over the past seven years have primarily volunteered their time to meet once a month and work on creative approaches to classroom learning utilizing microbial themes. Too often, educators attempt to tackle curriculum and educational change within a broad topic framework. The team approach has worked in part because we have stayed focused on microorganisms, not as a microbiology curriculum creation, but as a theme for learning about many aspects of science and other disciplines. “Less is more” as a curriculum concept has become highly valued in standards-based designs (AAAS Benchmarks, 1994), but Microcosmos shows that the concept may not only be needed directly in the classroom curriculum but in the actual structuring of science educational reform groups around topic areas.

A constructivist approach based on some of Vygotsky’s principles (1978) of the social construction of knowledge and refined by recent educators (Driver & Oldham, 1986; Yager, 1991) needs to be applied to students entering a university education program. Who these education students are—their ideas, feelings, preconceptions, changing personal meanings—must be recognized, and their
involvement can be ignited simultaneously with peer-centered, reform-oriented course work so as to immediately begin to be connected to change in the real world of education.

Thus, many of the Team members today began their contributions in the program while they were students in the Master of Arts in Teaching Science Education program. Their course schedules were heavy, but even minimal involvement in the Microcosmos program brought these individuals early on in contact with currently practicing teachers and other professionals. Moreover, it helped to establish a mission, an identity in which university education was not divorced from the school districts, the everyday middle school classroom problems, the communities of parents and workers who care about their children's education. Rather, university education students could immediately begin a connection and even a contribution, not out of arrogance but out of an evolving self-realization that players need not start by being only spectators.

The Team concept brought together these graduate students with experienced, creative professional teachers from area schools, writers, artists, and scientists. Scientists were mostly represented by members of an International Advisory Committee. We asked selected individuals from various countries who were specialists in aspects of ecology, microbiology, education, genetics, and industry to be a part of the Committee and of our advice as well as scientific review and credibility. Currently, scientists from nine different countries are represented. Moreover, my principal background was in biology research; I could see the great need for translating science concepts and everyday research into classroom expressions, and thereby I was someone with whom noted scientists interested in education could connect.

Today the Team is represented by nine full-time teachers, including two from middle school, six in the secondary level and one in a small college who previously taught at the high school. Of these nine teachers, three are currently enrolled in science education doctoral programs. Two others took an early Microcosmos workshop and became so involved that they were invited to regularly be a part of the Team. One of these teachers specializes in bilingual education, teaching science to mostly Spanish speaking students. Two other Team members are within the informal education domain, having had extensive experience over many years in zoological and botanical garden settings, working on exhibits, animal and plant care, and education, and another successfully took on the role of education coordinator at a children's science museum. Two Team members work full-time as curriculum developers with well-known educational consultant firms, although in both cases their involvement in the Team predated these positions. Three undergraduates are currently involved, including one who is experienced in environmental education, another in music education, and a third in social studies education. Another is a former undergraduate in science education and now works in biomedical research. Two others are primarily artists, but both teach as well. One teaches art part-time in a public school along with her studio work in woodcuts, bookbinding, and oils, while the other does free lance drawings and teaches an intensive computer graphics course. Another is a director of a hands-on biotechnology education program where he teaches, designs curriculum, and conducts workshops for teachers. Of the 21 current Team members, 10 became involved in the program during or near the conclusion of their Masters studies in science education while two others later enrolled in the Master's program, after extensive involvement in the Team. While such a descriptive listing may seem tedious, it is important because it illustrates the great diversity, creativity, and developmental evolution of the collective. This diversity appears to be crucial to the success of an educational reform group.

Nevertheless, the Team has evolved as an informal, volunteer-centered body. There has been an informal, camaraderie spirit to the program since its inception that seems to be key to fostering creativity as well as going on unity. This minimalist structure appeals to many creative teachers and students, for it is an alternative to the constraints they see in their own daily education professions and endeavors. Microcosmos work represents freedom of expression and innovation for these individuals.

Microcosmos also helps fulfill social peer learning and professional interaction needs. Teachers are traditionally operating in isolated frameworks. Even students at the graduate and undergraduate levels frequently feel alienated from their roommates or other students whose interests are elsewhere or who are not seriously embracing studies. The Team offers a non-competitive, non-threatening social structure. Occasionally subcommittees or partnerships are proposed to work on a certain task. These individuals meet on their own and periodically report back their work and receive feedback.

There is an ongoing open management style to the program. Team members recognize that all ideas are welcome, that new explorations (we have pretty much abandoned the use of the word "lesson") can be proposed and supported. In many group of forts, money in some form or fashion frequently gets in the way of the program effort and the ultimate goals of
positively impacting classroom learning. Within the Team, “money friction” has been avoided by an openness in which the Director discusses use of funds and makes clear that whenever grant moneys allow, consultant fees for teaching or direct workshop preparation and follow-up will be shared. All members of the current staff, which includes two full-time and three part-time workers along with the part-time Director, are members of the Team.

Beside these features of the Team and its evolution, Microcosmos was not a program created by money, grants. The University allowed some space to be used in science education due to the need enliven the facility. The space was allotted, an international advisory board formed, and initial exploration ideas discussed prior to any funding. Indeed, the first four years of the program featured the development of the nearly 500-page Microcosmos Curriculum Guide to Exploring Microbial Space by the Microcosmos Team and now in its third printing with Kendall/Hunt; the creation of a viable workshop format for in-service teacher training that resulted in not only a score of intensive workshops at the University Microcosmos facilities but over 250 mini-workshops and presentations of f-campus at school districts, museums, and science education conferences around the United States as well as other countries—reaching initially hundreds of teachers and eventually thousands of classroom students; and, the gradual building of a small museum for educators that features low-tech, hands-on representations of many of the ideas and explorations expressed in the Curriculum Guide. These vast, time-consuming activities which helped build momentum for the program’s objectives all were initiated prior to any funding and were brought to success levels with minimal funds. Small grants and some copayment for workshops by teachers and school districts totaled less than $75,000 over the initial four years! University support was key, but it was clear that this kind of program could bring in additional quality students and bring broad recognition to the school’s science education program as an innovative learning center, both of which have happened.

But the essence of the program was based on the people-centeredness of the effort from the outset. It was “grassroots” in the sense that it was not top heavy with professional program developers and administrators, but instead blossomed from hard-working students and teachers. Remarkably, many of the Team meetings over the first year or two seldom brought up the topic of funds, as most of the participants wanted to discuss exploration ideas. When we received major funding from the National Science Foundation in 1992, the Team felt that we had truly earned it, and this funding would allow Microcosmos to build on its already established curriculum, workshop, and exhibit center base.

Another model aspect of the program has been the way in which our in-service workshops have been organized and conducted. With a Team approach, we are able to consistently bring in a variety and diversity of faces, styles, personalities, and approaches that help to make the daily presentations dynamic. Teachers taking our workshops consistently remark in feedback that the variety of presenters and their informal but respecting manner makes the workshop click. Furthermore, the workshops have evolved to where the Team both directly models how explorations from the curriculum can be conducted in the middle and secondary classrooms, and allows for idea circles and discussion formats on overarching and frequently cutting edge pedagogical topics such as authentic assessment, integration of constructivist teaching, building systemic change, reflective learning, heterogeneous classrooms, and integrative curriculum.

Workshops introduce and model new ideas or additions for science classroom use. For example, Microcosmos proposes a learning cycle model that evolves from Karpilus (1977) and a constructivist base, centers around inquiry oriented explorations (Schwab, 1962), and consistently features the actual creation of a physical outcome, usually in small sub-groups. The outcome can be an exhibit, ongoing experimental apparatus, a model, a poster display, art or writing samples, or some combination of these. Nearly all of the explorations in the Microcosmos Curriculum Guide feature such outcomes: Microbial cylinders, mold displays, micro-discovery boards, Microbingo game boards, marbling art microbial simulations, flasks of root beer and so on. These creations are discussed, interpreted and are often referred to and directly used throughout the teacher’s curriculum during the school year. Thus, the students have a direct part in building a personalized, stimulating learning environment that is truly “theirs,” and they are directly contributing to the teacher’s stimulating, albeit flexible, curriculum. The creations, while directly involved with microbial themes, connect to a wide variety of topics in a science curriculum, which further reinforces our central concept of using microbial life as a vehicle for science enthusiasm and learning. This same physical outcomes approach that contributes to the students’ building a learning environment can be applied to any classroom discipline design and thereby become a central strategy in general education reform.

From the start we have worked to build bridges linking cultures, knowledge, and attitudes in America.
with other countries. Even today, the Microcosmos International Advisory Committee has representatives from nine countries. This approach has grown beyond our expectations, as we have through direct workshop presentations and our follow-up network forged solid linkages to teachers in Spain, Canada, Denmark, and New Zealand. A long-range goal is to have each American alumni teacher in our network “paired” with an alumni teacher from another country for an ongoing, personalized, more structured exchange of ideas and methods among professionals. Being linked internationally while working regionally enhances educational reform structures, even when those linkages are mostly informational.

Lastly, teachers both here and abroad who take our workshops or purchase the curriculum or visit our small museum facilities are not simply left on their own. They become part of a science education network, now broadly seen as important to teacher enhancement. Through the network, they receive occasional articles on microbial or educational themes of particular importance, the periodic Microcosmos newsletter, and workshop announcements for alumni—i.e., special courses that teachers who have been using the Microcosmos explorations in their classrooms can take. It is not unusual for us to receive photographs from past workshop participants showing their students working with the Microcosmos materials or to receive occasional notes letting us know how they are doing in their work. Moreover, our current NSF grant allows for stronger network development and further dissemination of the Microcosmos ideas by requiring that all workshop participants later conduct regional mini-workshops with specific guidelines. A unique feature of this effort is that Microcosmos Team members visit some of these regional workshop sites in follow-up. Through face-to-face contact the Team can build stronger, quality alliances among teachers and administrators.

In summary, while Microcosmos has many shortcomings and a great deal to learn, it has evolved as a model for teacher professional development and science curriculum enhancement, particularly at the middle and secondary school levels. Key features include: the establishment of an informal, committed, diverse, and teacher-centered group of people; the reliance on a people-power approach rather than building from a heavily funded idea; linkage to a specific theme or topic around which experts in the form of an advisory board can be created; the actual modeling of innovative and reflective learning within the workshop formats; the boldness to promote new learning models and ideas; the ongoing internationalist base which fosters healthy exchanges and respect; and the fostering of a growing network of teachers who are permanently linked to the project.

Microcosmos is seen today as somewhat unique. We feel that major inroads in science educational reform will take place across the United States and in other countries when Microcosmos is not so special, when there are scores and even hundreds of similar decentralized, informal working collectives in regions around the globe—indeed when different groups discover and peel away their own “paints.”

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HETHERSETT OLD HALL LINK
WITH WULUGU, NORTHERN GHANA

Lynne Symonds
Head of Science, Hethersett Old Hall School

Hethersett Old Hall is an independent school for girls age 8-18. It is a day and boarding school and is situated in East Anglia, Britain. Students from the school have established a strong link with students in remote Northern Ghana and the project has been extremely beneficial to both schools as well as to the whole area of Ghana surrounding the school.

In the autumn of 1993 the Head of Science from Hethersett Old Hall, Lynne Symonds, was selected to be part of the British team visiting Japan on an education/industry study tour of international educators. (Tour organised by the Japan Foundation.) Mrs. Symonds was able to form links with many parts of the world as a result of this tour, but to date the most fruitful has been that with Northern Ghana. The project began after a discussion between Karimu Nachina, Head of Wulugu School, and Lynne Symonds, which actually took place while waiting to meet the Minister for Cultural Affairs in Tokyo. Mr. Nachina told Mrs. Symonds that he had enormous problems in his school, largely associated with the education of girls. The Ghanaian school is too far away for students to walk each day from their homes so many have to board in local houses. Not only is this expensive, so deterring families from paying, but also it is hazardous. This is a polygamous society and girls can be treated as extra wives, becoming pregnant, dying from abortion, etc.

Mr. Nachina and Mrs. Symonds decided to try a trans-continental peer group education scheme, involving girls from the VIth form in Hethersett writing to similar age girls in Ghana.

Students at Hethersett were intensely interested in the lives of the Wulugu girls. They learned first hand about issues which can soon become ‘boring’ if taught in the normal way. If you hear that your friend in Ghana has malaria, has 23 living in her grass-roofed house, has not been to school because she has to work on the farm, then interest and real hunger for knowledge about wide ranging scientific and sociological issues is guaranteed. The English students are so very aware of alternative energy, appropriate technology, medical issues, etc. that they can speak with more authority than the majority of people who have read second hand accounts. They also developed real appreciation of their own school, well equipped, with books, desks, electricity and teachers (all often lacking in Northern Ghana).

The exchange of ideas and information has extended and is proving invaluable in the music, art, home science and geography departments in both schools. Also we are currently developing the student-student link to involve younger students.

The Wulugu students became keener to learn. They knew that their English friends were genuinely interested in them and the school reported quite dramatic improvements in attitude despite a gross lack of equipment and some measure of hunger. Within six months the number of pregnancies began to fall but of course no conclusions can be drawn from this.

One of the many fascinating letters from the school in Ghana revealed that they had a great need for books—in fact they asked for ‘anything you are going to throw away.’ This prompted the Old Hall students to collect 5 tonnes of books from friends, publishers, shops and other schools. A local businessman, Barry Brooks, volunteered to help organise and to pay for the transport but things were far from easy. The government in Ghana was keen to accept the books but wanted to distribute them as they wished possibly to high status schools in the south.

Wulugu is a long difficult journey from Accra, but Philip Parfitt, working for Barry, organised the whole trip successfully. When the books had arrived in Wulugu, Mrs. Symonds had an ecstatic phone call late one night from a Ghanaian who announced—

“I’m Francis and I did it—I got your books there. Everyone is amazed—they cannot believe it.”

Francis has now become a regular phone caller and friend.

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The books were received as gold, again the whole area celebrated they were completely overcome and set to work sorting, labelling and establishing a library. This library became a centre of attraction and the whole of Ghana seemed to learn about it. They named it the ‘Lynne Symonds Library’ and the opening was shown on national T.V. in Ghana. It seems very sad that these wonderful people should celebrate receiving our left-overs in such a fashion. However the high status of this library aids retention of teachers as well as encouraging parents and children in their education.

The headmaster at Wulugu has said he does not want to become an ‘African Oliver Twist.’ However the students in Old Hall are collecting now to build a boarding house where girls can live safely—they are: aiming for £8,000 but obviously the school will use whatever they send. During the progress of their fundraising the Hethersett girls have contacted Ghanaian students at the University of East Anglia who have helped to encourage their projects.

This link between two schools seems to be providing real aid to an area where the average lifespan is falling. Ghanaians are being encouraged to learn, particularly in the important areas of home science and agricultural science. The girls will become more aware of hygiene, nutrition and simple medicine, as well as able to read instructions on contraceptive packets. These skills will help them to take decisions about their lives and those of their children. Agricultural science lessons will enable better use of resources and perhaps improve living standards. The people in this area are mainly subsistence farmers but they are very aware that the high degree of illiteracy in the north is largely due to political decisions to concentrate resources in the south. The Northern Ghanaians have a more difficult climate and fewer natural resources so it is important that they are aware of possible solutions to their problems. Baroness Chalker representing Overseas Development Administration said in a recent interview (T.E.S. 6.1.95):

We are trying to help people to help themselves. We cannot get good governments in developing countries unless people are literate and numerate; likewise we cannot help people who are unable to read instructions on something as simple as a packet of seeds. One of the major thrusts in development policy is to promote literacy particularly amongst girls.

The girls at Hethersett Old Hall are endeavoring to provide sustainable assistance to Wulugu. At the same time their own education is being greatly enriched. The project has done a great deal for the self esteem of students and teachers in both schools and it is an idea which is worth repeating. Other British schools could link with other schools in English speaking Africa. French schools could link with French speaking Africa. The scope for development is enormous and, from our experience, rewarding for all concerned.

A SCIENCE EDUCATION CENTER AT UNIVERSIDAD DE LOS ANDES

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This short paper is a proposal for a new Science Education Center in Venezuela. The authors would like comments, criticism, and indications of interest and involvement from science educators world-wide. Please contact them at the address shown at the end of the article.

Human resource development is at the very heart of the developing process.

Frederico Mayor
Director General, UNESCO

Rationale

Throughout the world, leaders are recognizing that full participation in democracy and growth requires science literate citizens (Bowyer, 1990). At the UNESCO World Conference on Education for All (1990), the ministers of education from virtually every country in the world affirmed the notion of “science education for all,” meaning every person, not just the elite preparing for careers in science, mathematics, and technology. The current UNESCO/ICASE Project 2000+ endeavor affirms that this grand goal is being sought in many ways in many
places. Project 2000+ recognizes that a science education for all necessitates different goals for students and a very different approach to schooling than is traditional, especially in many countries of Latin America. We strongly support Project 2000+ and wish to be a part of its growing international momentum by creating a Latin American and Caribbean Center for Science Education at Universidad de los Andes (ULA) in Merida, Venezuela.

The Latin America and Caribbean region contains vast resources and potential which, for development, demand a population well-educated in science, mathematics, and technology (SM&T). Currently, many of these countries rely for innovation on either local initiatives or ideas imported, typically, from North America or Europe. While these provide for needed growth, a truly sustainable educational development requires that Latin America and the Caribbean be more than passive recipients of ideas. A Center for Science Education at Universidad de los Andes could both provide for the indigenous development of Latin American and Caribbean ideas and be a nucleus for their dissemination. ULA is a natural setting because of its relatively central location, its heritage (established in 1785), administrative support, and its well-established position as a leading center for research and education.

Our Mission Statement

The Science Education Center of Universidad de los Andes is dedicated to the promotion and improvement of the teaching and learning of science, mathematics, and technology for all persons at all levels throughout Latin America and the Caribbean.

The Vision

We see the Center for Science Education as fulfilling a variety of functions including:

1. Designing and conducting research related to the teaching and learning of SM&T at all levels.

The body of literature related to effective teaching is growing quite rapidly. While much of the present literature pertains to Latin America and the Caribbean, we have our own unique heritage, situations, perspectives, and problems which require investigation and analysis in the unique context of the region. In addition, we must move ahead to be producers of research, curriculum, and new ideas rather than waiting, passively, for ideas to filter down from more developed nations. This research would also serve to link faculties of science, humanities and education in joint ventures to improve schools and schooling.

2. Designing and delivering pre- and in-service teacher education in SM&T, including methods of teaching, the content to be taught, and new technologies.

At the core of a science literate citizenry is education, especially in the pre-university years. Leaders world-wide acknowledge that, currently, only elite students receive an adequate education in SM&T. To remedy this, we need the best possible teachers we can produce. Rather than passively accepting teaching as an untrainable art, we must design and implement the most effective programs to change how teachers teach and think about teaching. Powerful models exist; if we add to these models our own research and the thinking of the best minds, we can create a teaching force which is second to none and students who truly understand and can apply SM&T.

3. Providing consultation, leadership, and training in the development, and instruction for education in science, mathematics, and technology.

Many academic departments, schools, industrial training groups, and government bodies need seminars, workshops, and advice aimed at improving the educational development or knowledge of their constituents. Affiliated with our Center will be a variety of scholars and professionals from many disciplines and nations, each ready and prepared to offer such advice. The Center will maintain a professional data bank and promote linkages and relations with such persons in order to facilitate this process.

4. Developing appropriate assessment techniques and technologies.

Society’s goals for citizens includes attitude, performance, creativity, and communication in addition to mere learning of the content and skills. If we are to meet these additional goals effectively, we must both teach for them as well as evaluate them in the classroom and beyond. As few assessment instruments are available, especially in a Latin American-Caribbean context, we need to adapt, modify, design, and test until we have techniques and instruments which meet our needs.

5. Developing policy statements related to the teaching and learning of SM&T.

Education is more than a teacher and students in a classroom. Unless national standards, attitudes, and policies reflect the overall goals of SM&T, little innovation or progress will occur in the classrooms of
our nations. Overcoming this requires working with policy-makers to develop position statements, documents, procedures, and even institutions which affirm the goals, research, and directions which truly support and encourage SM&T literacy.

6. Establishing and maintaining cooperative links with science education centers, science teacher associations, established groups of SM&T researchers, and science teacher educators worldwide.

Communication is the essence of research in science. So, too, communication is a vital ingredient in research, development, and implementation of educational ideas. We will serve as a center for such communication among scholars and professionals world-wide, bringing science and education professionals together. Each year, the Center will house visiting scholars, both students and professors, and, at the same time, will facilitate mechanisms for regional scholars to work at similar centers in other nations. Both of these will add to the richness of our knowledge base while enhancing our regional capacity for educational research and development.

7. Establishing and housing a library for materials and educational technology useful for SM&T education.

Our library will contain the usual books and journals and provide for interlibrary loans but will go considerably further, taking advantage of new technologies. We will provide educators and researchers with access to international data-bases and other students and scholars via computer linkages. Our materials will include computer software, courseware, simulations, and laboratory interfacing and other instructional technology so that teachers and researchers may evaluate their potential value and learn to use them.

8. Disseminating, world-wide, information and ideas related to SM&T.

Through newsletters and a periodic journal, the Center will communicate with numerous individuals and provide a forum for intellectual discussion. These media will also provide ideas of practical importance and new knowledge directly to teachers and others. Just as with the scientific enterprise, we will communicate with all science educators worldwide and be active partners with associations and groups dedicated to enhancing the SM&T literacy of all citizens.

9. Creating and coordinating SM&T activities for pre-university students.

Pre-university students often become university students and, eventually, enter science careers or teach at various levels. We must ensure that they have available appropriate opportunities to fully participate in SM&T activities. At the same time, those students who terminate their formal education earlier must have multiple opportunities to participate in learning experiences which help them understand and appreciate science. Thus, the Center will encourage and sponsor a variety of field trips, short courses, research experiences, science fairs, publications, associations, and competitions for pre-university students, beginning with the very young.

10. Encouraging the development of SM&T professional associations.

At the heart of an effective SM&T education lies the teacher. Sharing of ideas in a public forum is a key to enhancing the knowledge, skills, and professionalism of our teachers at every level. Professional organizations provide such a forum as well as opportunities for collegiality, communication, leadership, and debate. The Center will assist in the development of associations and will, itself, be an active member of the International Council of Associations for Science Education (ICASE) and the World Council of Associations for Technology Education (WOCATE).

Organization of the Center

The Center for Science Education will be an independent unit of Universidad de los Andes, reporting to the Vice-Rector. While basic funding (facilities, the Director’s salary, a secretary) will be provided by ULA, the Center will seek grants from national, regional, and international agencies for operations and specific projects. The Center will include a physical facility with offices, classrooms, a library, and a laboratory for development and testing of laboratory activities. Development of relationships with schools will allow field-testing of curriculum and instructional materials in real settings. Permanent staff will include a Director, clerical staff, and various assistants. Faculty members from a number of academic departments, universities, and nations will be invited to join the center for varying lengths of time. Sometimes they will be housed at the Center and other times they will be intellectually involved without being physically present.

In addition to guidance from the Vice-Rector, oversight will be provided by an International Advisory Board (IAB) consisting of eminent scholars from education, science, mathematics, medicine, engineering, and technology. The director will communicate frequently with the IAB and they will advise the Director, probably via an electronic conference, on a regular basis. The IAB will also be charged with keeping the Director and faculty cognizant of current trends and work in science education.
References

The Authors
Mauro Briceño spent the 1994-1995 year at the University of Iowa working in the Electron Microscopy Research Facility. The former Dean of Science at ULA, Mauro is now devoting a significant portion of his time to enhancing SM&T literacy.
John Penick, Special Projects Officer for ICASE and former Director of the Science Education Center at Iowa, has been working with him to create a similar center at ULA.
They truly would like to have your input and involvement. If you have comments or criticisms, or wish to be on the Center’s mailing list, please contact John at the Science Education Center, University of Iowa, Iowa City IA 52242, USA. Or, contact him via e-mail at John-Penick@uiowa.edu.

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Current Educational Problems in Japan
As many scholars in education have discovered, the Japanese educational model, since World War II has developed ties to U.S. education. In turn the Japanese educational system has become a model for many other countries. But, in actuality, there are many problems with science education in Japan. The development of science and technology brings new problems to the present Japanese society, including lack of confidence, as well as a failure to humanize the subject.

Even with these problems, there is a consensus that more and better science and technology are needed in Japan to promote a better life. In 1989, the reform of the Course of Study, called National Standard Curriculum included a re-examination of the interrelationships among science, technology and society. However, critical deficiencies in the Japanese approach to assimilation attempts were noted when compared to the Science/Technology/Society (STS) movement in the U.S. (Kumano, 1991).

One of the major features of Japanese science education relates to how the system of education is organized. The National Standard Curriculum identifies what every school should teach at each grade. It is generally revised every ten years. Recently, the science content for each discipline has been decreased (MESCNC, 1982, 1989). The Ministry of Education also dictates the number of instructional hours each course will have as stated in the official Course of Study. From 1971 to 1979, 698 hours of science were designated for grades one to six. This number was dramatically decreased to 546 hours for the 1980-1991 interim. It was again decreased to 420 hours for 1992 and beyond. Similarly, the time for junior high school science was shortened from 420 hours (1972-1980) to 350 hours (1981-1992) and 315-350 hours for 1993 and beyond. Such decreases in the time allocated for science lessons illustrate that science education is becoming less important in Japanese society.

Another reason that some call the current situation ‘one of crisis’ is the changes in individual life styles that are occurring as well as general changes in Japanese society, caused by the rapid development of science and technology. It is not an exaggeration to identify the major problems today as having come from the interrelationships among science, technology, and society. Many citizens believe that too much development of science and technology may be harmful to Japanese society. People are being inundated with too much information in too short a time. People are becoming
more focused on individual priorities and materialistic goods. Time and space among people is becoming smaller and smaller. Physical changes in the environment produced by modern human beings cannot be predicted. The development of science and technology in the context of a changing society requires an attitude change on the part of teachers and students. Most of the teachers say that students are becoming more self-interested and desirous of an easy life. Communication between teachers and students is changing; respect for teachers is decreasing; some students look at teachers as teaching machines. Younger teachers have changed and, like their students, they long for the easy life.

Standardized examinations for college or university entrance pose still another reason for designating the current situation as one of crisis for science education in Japan. For many the main goal is merely to get better scores on standardized examinations during the senior year of high school. The major purpose, then, is drill and practice in order to learn many science concepts by rote memorization and to review questions likely to appear on the examination.

In reflecting on all of the current problems in science education in the Japan, it is easy to argue that the situation is likely to worsen within the next 10 years. To resolve the deepening crisis, new corrective efforts must be undertaken now. Grayson (1984) examined and analyzed Japanese science and technology education and he proposed interesting ideas. He observed, “For the first time, Japan is in the position of having to advance the state of knowledge, do advanced research, and create its own technologies. Japan must develop a creative, more knowledge intensive industrial structure” (p. 298).

**STS Instruction in Japan**

Before Nagasu’s work (1987) there were almost no studies reported which focused on STS instruction in Japan. Nagasu (1993) has summarized the studies reporting on STS efforts in Japan between 1983 to 1993. About 30 studies have been completed which illustrate the emerging STS efforts in Japan. Twenty-six studies concerning STS in foreign countries have been reviewed for special relevance in Japan. At the time of the first National Convention for the Society of Japan Science Teaching (SJST) in 1992, a special session on STS was scheduled at the Joetsu University of Education. The 1993 National Convention at Fukuoka University of Education established a new area of study in science education called “STS/Environmental Education.” Eleven presentations dealt with STS, 16 presentations were concerning constructivism and six presentations discussed this new philosophy. So all together 33 presentations (about 20%) out of 174 had strong connections to STS. Another major association in Japanese science education is the Japan Society for Science Education (JSSE). The National Convention of JSSE was held at Okayama University of Science in 1993. During this convention seven presentations were directed toward STS, and 18 presentations discussed constructivism representing about 20% of the convention presentations.

At least five governmental institutions in education are doing active research on STS for science education: The University of Tsukuba, Kobe University, Shizuoka University, Osaka University of Education and Ibaraki University. Many institutions have developed STS courses based upon their own departmental or institutional interests. In most cases, those STS courses are called ‘integrated or synthesized.’ There are also some institutions or departments whose main research is targeted on STS including the University of Tokyo.

Two important researchers in STS visited Japan from the U.S. so far. They were Professor Robert E. Yager, of the University of Iowa and Professor Rustum Roy, of Pennsylvania State University. They were invited by the Ministry of Education with university funding to an international conference and had a great influence on STS for Japanese audiences.

More and more researchers in science education, government researchers in science education, administrative researchers, and science teachers are getting involved with STS in Japan. However, the swiftly changing situation is complicated by many biases of academic scientists and science teachers. The definition of STS is not stable in Japan. University scholars frequently search for a solid theory to explain their actions and advocacy positions. However, there is a difference between understanding STS in an academic sense and using STS in a science class. STS has not only become the target for research in science education and other fields; it also provides practical learning activities for future citizens who prepare for life long learning.

**Future of Japanese Science Education with STS**

STS has a great potential in the development of science education in Japan. Data from STS classes showed great increases in creativity and other important domains (Yager, 1993). STS asks not only students but also science teachers and whole schools to have a major paradigm shift toward constructivism, the new philosophy of teaching. STS calls for major changes for preservice education and in-service
education in Japan. Only one dissertation on STS for Japanese science education written about the Iowa Chautauqua Model was completed by Kumano (1993) showing many interesting findings between the two cultures.

Japan has a national standard curriculum in every subject approved by the Ministry of Education, called Course of Study; 'Gakusyu Shido Yoryo' in Japanese. Also, the Ministry of Education is keenly focusing on in-service science teacher training to meet the national standard. We need a two step approach for the implementation of STS in science education. At first a short term strategy can provide understanding, performance of the goals, and evaluation of STS. We need to promote development of STS modules as a new paradigm of science education during pre-service teacher training for elementary and secondary levels. As a consequence, STS teachers will greatly increase in number. Secondly, the long term strategy must involve a systematic and long-term approach. Lead universities such as the University of Tsukuba and Shizuoka University, are trying to conduct the in- and preservice training program based upon STS education as a new paradigm for science education. We also will need more communication concerning STS with other countries. We need more detailed evidence concerning STS in the Japanese setting and we need to develop Japanese STS models. Government grants and private funding will be needed to support continued STS research in Japan.

With all those process mentioned above, both lead teachers and lead universities will be able to cooperate and synthesize a Japanese STS education model, based on philosophical and practical studies. As the results of this synthesis, our society will have a new direction with a wider and deeper philosophy and practical studies. Eventually, STS education shall be adopted by the Ministry of Education in Japan.

Reference

FROM OBJECT, THROUGH WORD TO UNDERSTANDING: LANGUAGE DEVELOPMENT THROUGH SCIENCE ACTIVITY

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Science activities are interesting, practical and shared, so science activities are an ideal context for language development. This should not surprise us, as people learn language best when they are motivated, and interesting things motivate. They learn language best when they are engaged, and practical activities engage. They learn language best when they work together, and shared tasks involve this.

The mesh between the considerations which underlie both conceptual and language development at the Primary school level provides an opportunity for an integrated response which is too good to miss.

Many activities can be devised which build towards the acquisition of science skills and concepts at the same time as encouraging the general language development of the children. Shared activities demand a certain degree of language competence. However, the immediacy of science activities means that the language requirements are usually very modest. Students with very little command of English can often share with native speakers in practical activities. This is also true of groups whose members are closer in language competence. An activity approach allows children who are operating at different levels to benefit from time spent together, as they take from each activity, and from the surrounding talk, those things which they can assimilate. Properly structured activities will encourage the use of particular areas of language, and the less adept children will take up the language used by the more confident. In fact, the range of experiences and abilities possessed by different children can be a real asset, as groups come to grips with novel relationships between familiar objects and situations. Science activities are one of the few places that an otherwise silent student can make a real contribution. This helps both the more adept, who may come to see the new participant in a new light as they accept their help, and the other, who assumes a more active role in the class. The activity base of primary science makes it possible to draw on the whole wealth of experience which children bring to class.

One example of a language rich activity follows, accompanied by a discussion of the areas of language which could be developed through it. The activity itself is an adaptation of a fairly common children’s game.

1.2 Memory Chain
Objectives
The children will be:
- observing features of a natural object
- describing a natural object

Materials
For the class:
- any fairly large natural object with interesting features such as a twisted, gnarled piece of driftwood, an animal’s skull, a spiky, intricate, patterned shell, a piece of marble.
- a list of about ten words describing the object including words you suspect your class will not think of (these do not have to be ‘big’ or ‘technical’)

Activity
In this lesson you will be working with one group of children at a time. Make sure that you have work for the other children to go on with.

1. Hold up the object and ask the class to suggest words to describe it and record the suggestions on the blackboard. If appropriate, show how phrases such as ‘it
has zig-zags’ can be changed to ‘zig-zagged.’ Add some of the words from your own list.

2. Sit a group of around 10 to 12 children in a circle (while the remainder carry out other work). Let the children take turns at looking at and handling the object. Place the object in the middle of the circle or have it passed around the group as the chain develops.

3. Start the chain with a sentence like, ‘Here we have a large piece of driftwood.’ The first child then says, for instance, ‘Here we have a large, honeycombed piece of driftwood.’ The next child says, ‘Here we have a large, honeycombed, knobbly piece of driftwood.’ Continue in this way around the circle, with each child trying to recall the sequence of descriptive words and adding a new one to the chain. Let the children use words from the blackboard if they cannot think of their own. Jot down the words as the chain grows and see how long the group can keep the chain going.

4. Repeat the memory chain game with the remaining groups of children in the class.

5. After everyone has had a turn, write each group’s chain on the blackboard so that groups can compare their work.

(Freer & O’Toole, 1990 pp 5,6)

This activity never fails to interest children, as they work together, expanding their repertoire of words and practising precision in description, a skill which is appropriate to both science and language. The sophistication of the description produced will depend on the object used and the experience and imagination of the children. Students from a wide range of language backgrounds can fruitfully share in this activity. The more adept provide more sophisticated describing words, and the less adept participate actively while being exposed to new words. Further, the activity leads all of the children towards those chains of words which are a feature of mature scientific writing.

This is probably a good place to discuss the issue of specialist language styles in the primary school. Science has a distinctive style of language, of which word chains are a part. The style provides a significant barrier to learning in the secondary school and beyond. I do not believe that it should be introduced into the primary school. Primary science is about exploring, investigating, understanding and refining. We should be concerned with these things, and not with the introduction of specialist language styles which will only impede the successful acquisition of those skills and understandings which are our proper concern. The specialist styles of English can await a later day in our children’s lives. However, sometimes, as in the activity above, an opportunity presents itself to deal with the precursors to aspects of specialist English. Such opportunities should be recognized, but how far they are explored will depend on the interests and abilities of the particular class.

The simple example presented here is drawn from a resource which had language development as one of its major aims (Freer & O’Toole, 1990). However, many of the activities making up other published primary science resources can also develop students’ language. “Look!” (Gilbert, Matthews, & Monaghan, 1990) is a mine of activities, “Cracking Up!” (Jakab, Keystone, & Lambert, 1989) illustrates the potential of thematic work based on science, and “Informazing” (Clyne & Griffiths, 1990) integrates language, science, mathematics and information skills in a highly motivating group discussion context.

Take Hold of the Opportunity!

Good primary science involves children working together, on shared tasks involving the manipulation of everyday objects, towards refined understandings of the world around them. This is an ideal context for the development of language skills. Science activities can allow groups of students from a range of language backgrounds to work together, learning more about their world while expanding their language repertoires. Primary children do not need to produce the specialist scientific style of English, but the activities of science, and the directed talk and writing which happen around them, provide a rich context for the development of general language skills.

References


Teaching Materials and Strategies

This section focuses on the education of science teachers, and aims to communicate ideas and strategies which will assist science teacher educators to enhance and enrich their programs.

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PRIMARY SCIENCE EDUCATION IN GREECE

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Introduction

Educational changes in Greece have been limited to the “extrinsic rearrangement” of education (legislation, establishment of new types of schools, structures of schools, etc.). They have not concentrated on the core of educational reality (intrinsic rearrangement) methodology, curriculum, books, teacher training, etc. (Terzis, 1981).

It was in 1964-65 that the first steps were taken by George Papandreou’s government to change educational policy and impose a new national curriculum (Kazamias, 1983), only to be stopped by the 1967 dictatorship. Years later, a new attempt to change educational policy created the “Educational Renaissance of 1976.” However, it was not until 1982 that this policy was implemented in schools through a new national curriculum and new textbooks.

The new Greek national curriculum includes four basic structural elements (Xohellis, 1981):

- Objective didactic targets
- Content
- Methods of teaching
- Testing

Changes in all the above elements have already influenced the qualitative results of classwork.

The new national curriculum was introduced gradually, starting in 1982, by modifying new textbooks. The new textbooks, which have been gradually introduced for the first time in primary education, cover areas of Greek language, mathematics, study of environment, discovering the natural world, and social and political education. The new national curriculum was written by the Department of Primary Education of the Pedagogic Institute—an important department of the Ministry of Education.

Schools and School Science

In a primary school, which caters children age 6 to 12, there is science instruction starting in the first grade. There is very little science instruction in nursery school (children age four to six). From the ages of 12 to 15, children attend middle school (compulsory education) and science is taught in separated subjects such as biology, physics, chemistry, etc., by science teachers; some of them with varying amounts of training in science. From age 15 to 18, children attend secondary school and science is also taught as before but at an advanced level.

Primary School

In a primary school class, the average number of pupils is around 30 to 35. There are two other types of primary schools found in remote rural areas:

1) primary schools with all six grades in one classroom;

2) primary schools of six grades in three classes where each class includes pupils of two grade levels.

For pupils of the 5th and 6th grades, the assessment for primary school pupils is the average of two marks:

1) an oral grade which comes from tests, oral exams and homework;

2) a written mark from written exams in each of the taught subjects at the end of the school year.

There are three terms in a school year. At the end of each term, parents receive the oral record of achievement.

The 1982 National Curriculum and Primary Science

This curriculum was based on a pupil-centered approach to learning rather than the old teacher-centered approach. It was based on Bruner’s
theory for the structure of knowledge. However, the constructivist theory of learning science is also applied by considering pupils as active learners and taking into account their previous ideas about the natural world.

The methodology for organizing the knowledge in the national curriculum and new textbooks follows the prototypes of the USA and European countries, with the exception of the amount of time spent in schools—25 to 30 hours per week—because of the lack of buildings.

Most of the science teaching was focused on the content of science. Nowadays, national programmes in science education have shifted the emphasis away from content towards process. Process is how a scientist works, thinks and investigates. In other words, it is a method of investigating.

**Discrepant Events: An Alternative Teaching Process in Science**

As in most countries of the world, our typical primary teacher is responsible for many different subjects. Science is not the only concern and it is often the teacher’s greatest weakness. As a result, success in primary science is not easy to achieve. Within these teaching limitations they try to teach as much science as possible by taking away the complexity so often built into science teaching. Discrepant events provide teachers with many simple, concrete and easy-to-use examples of science concepts.

Discrepant events are events which are unexpected or surprising to the viewer. They are used because of:

a) the lack of suitable equipment in schools (very few instruments, or laboratory halls for physics, chemistry or biology) and they usually require inexpensive, everyday materials, and

b) the fact that discrepant events are often described as paradoxical, unexpected, and surprising. Thus, they tend to produce a rather strong feeling in the observer. Generally, he/she will have an inner feeling of wanting to know, wishing to resolve the discrepancy in his/her mind. Adults and children will display a desire to resolve the unexpected. Certainly, the enthusiasm of the latter will be even greater. Children will simply not rest until they find out why certain events occurred as they did.

It is obvious that when pupils are strongly motivated, conditions are favourable for learning. Therefore, any method which helps generate this motivation is worthy of investigation. Thus, discrepant events capitalize on the pupils’ own curiosity, helping him/her gain a better understanding of science.

Discrepant events have been used to teach the characteristics of matter, heat energy, static electricity, magnetism, current electricity, sound, light, lenses and colour, air and air pressure, weather and climate, just to name a few. At the same time, this approach develops many specific skills such as observing carefully, recording data, predicting, graphing (a form of recording data, estimating, formulating hypotheses, classifying information, comparing, measuring, inferring, generalizing, and controlling variables). All the above mentioned are methods of investigating which is the core target of the Greek national primary science curriculum. The methodology of teaching a discrepant event has the same framework and procedure used by “Stepping Into Science” activities (Tunniclefife, 1989).

**The New Textbooks for Primary Science Education**

These include programmed material for learning and methods of teaching in detail (quality, quantity, didactic actions and student activities, available time, evaluation of the success of learning targets, etc.).

There is also a teacher’s textbook for each subject and grade—a resource which all teachers had been waiting for. Each teacher’s and pupil’s textbook is the result of the work of groups of specialists—members of the Pedagogic Institute—or canonical under the guidance of the Ministry of Education. The new textbooks include what teachers need to know and what pupils need to learn. For instance, the pupils’ textbook contains all pupils’ activities, exercises and questions in a predefined format. Demaras (1979) contends that national control is needed to improve the textbook and protect pupils and parents from the high-handed acts of some editors. Hence, a common and compulsory book is imposed on all students at no cost to them. Teachers’ opinions are reflected in the research of Daniilidou (1984:87). He found that to a certain extent the textbooks help teachers save time in preparing to teach. However, they have found themselves incompletely prepared or lacking in knowledge, time or confidence to handle many new subjects. Members of the Pedagogic Institute who have designed and written these textbooks claim that “they aim to protect the teacher from sketchy improvisation and insecurity” (Pedagogic Institute, 1983:6).

**Results on the New National Curriculum and Textbooks**

The content renewal of the subjects “Study of Environment” and “Discovering the Natural World” has produced the following results in school practice:
1. Positive

The new national curriculum and textbooks in science has opened another horizon for science teaching and learning. Providing all learners with motivating experiential activities is an important didactic strategy, especially when teaching abstract science concepts and principles. Experiential activities, which may be thought-provoking or hands-on activities, have the ability to stimulate curiosity and motivation. The more contradictory the phenomenon appears to their strongly-held notions of the event, the better.

2. Negative

a) The time for teaching has not increased in proportion to the increased amount of content. A trial period has already proceeded the wide application of the new national curriculum. The benefits of pilot studies have included improving the content of daily lessons, methodology, and number of exercises, and have indicated the need of additional hour of teaching time in order to complete the content in each lesson.

A first proposal is the use of some time from other activities (music, athletics, arts) to complete the lesson. A second proposal is also in progress for additional teaching hours for both science courses. However, the teaching rhythm of the two subjects is intensive, producing anxiety in teachers and pupils, according to teachers' reports. Further research and evaluation of the new national curriculum in primary science education must be undertaken.

b) Specific attention must be paid to the professional needs and problems of primary teachers' education programmes in science.

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FOOD FOR THOUGHT

A hundred years from now it will not matter what my bank account was, the sort of house I lived in, or the kind of clothes I wore.

But the world may be much different because I was important in the life of a child.

Author: Anonymous
AIDS IS NO GAME: AN INTERACTIVE ROLE PLAY

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Editor's note: Students carry a glass with a mixture of water and milk, one student (unknowingly) with some starch in his/her glass. The students simulate sexual activity by mixing fluids in unsafe encounters, by just toasting (safe sex) or just chatting (no sex). In the end the test...... iodine (fluids which contain starch turn blue). This role play, with help of some simple chemicals, makes for a powerful simulation of the spread of STDs (sexually transmitted diseases). The activity has been used in several African and European countries and at several levels of education.

Abstract

The complexity of factors which influence sexual health led to the development of a health promotion tool which emphasizes not only individual risk-characteristics, but also the importance and unpredictability of interactions between individuals. This resulted in a role play which links knowledge with emotions in a non-threatening way. The play facilitates discussion and creates awareness of individual risk-behaviour, of power relations and of the ability to negotiate safe sex. Furthermore, it has the advantage of being fun, thus overcoming the obstacle which arises when sexual behaviour is associated with a predominantly negative context of illness and doom. The roles can easily be adapted to different cultures. Field tests in Botswana, Lesotho and the Netherlands proved the value of the role play in schools and other groups. The play can be meaningfully integrated into the curriculum (human biology or sex education).

Introduction

In countries such as Botswana, Lesotho and the Netherlands, HIV and AIDS are included in the science curricula for secondary schools. The aim is to develop knowledge, understanding and attitudes and to promote safe behaviour. There are many factors which influence behaviour. These include individual characteristics, peer group pressures, media messages, examples of role models and other persons in authority. Also gender issues play a role, for instance where cultural and social patterns encourage boys to be hunters and girls to submit to boys' wishes. These factors interact in a complex, virtually unmeasurable manner. Factors may combine and lead to higher risk situations, e.g., when passion or pressure gain the upper hand over knowledge or self-protective efforts in an encounter between partners.

The role play focuses on the importance and unpredictability of risk situations and promotes awareness of individual risk behaviour, the interaction between partners and negotiating safe sex. It facilitates talking about the sensitive issue of sexual behaviour. First the role play is described with suggestions and strategies for the facilitator. This is followed by findings in field tests in three countries with further suggestions for use.

The Role Play

The role play can be used for groups of 15 or more people aged 15 years and above. Prior to using the role play participants need some basic knowledge of HIV/AIDS. For instance: HIV is a virus that can cause AIDS; one can be infected without knowing or
being ill for a long time; one can be infected and infect others sexually; and an infection can be shown by a test. In other words, the play is not meant to teach the basic knowledge concerning the HIV virus and AIDS. This should have been taught beforehand.

Editorial comment: Role plays of this kind can also be used first, with little or no previous knowledge to provide experience with a concept so students have a common base from which to develop further understanding. Constructivism suggest that we build knowledge on experiences.

**Description and Materials**

All participants receive a glass of water with a bit of milk to make it turbid, symbolising “body fluids”. One participant also carries invisible starch in his or her glass—symbolising the “seropositive” starter. The participants meet each other, simulating encounters whereby safe sex, unsafe sex or no sex takes place. This depends on the role which each participant has been given and on the interaction between two partners. Safe sex or no sex is symbolized by toasting glasses - no body fluid is exchanged. In unsafe sex the partners mix the content of their glasses, thus spreading the invisible starch from “infected” to uninfected partners. At the end of the play the starch will be made visible by a iodine solution, as in real life where the infection with HIV is established by a test.

The materials for this play include a saturated starch solution, an iodine solution, preferably transparent beakers or glasses and a set of role cards. Each role card carries a name and a description of the characteristics of the person (Figure 1).

**Figure 1. Examples of Role cards.**

1. You are Bernard. You have three regular girlfriends and use a condom if asked to. Exchange and mix body fluids if you have sex without a condom.

2. You are Alexander. You have Christia as your partner with whom you have sex regularly. You are faithful to her.

3. You are John/Sarah, you do not believe in sex before marriage. You are attractive though and like company. You are a keen racing cyclist. You want to learn how to drive as soon as possible.

4. You are Edward/Virginia. You have as many sexual partners as you wish, since you are a star and very popular. But you never use a condom.

5. You are Sarah and want to become a doctor or nurse and you are a vegetarian. You are outgoing and fond of boys. Condoms seem a lot of fuss when the pill is so easy.

6. At last weekend’s pop festival you met a girl you fancy but you think you are too young to be tied down yet. You have not really thought about contraception, it is something up to the girl. You never wear white sox, you are a supporter of Greenpeace.

7. You are Alina and have Bernard as your partner with whom you have sex regularly. You are faithful to him.

8. You are Robert. You do not have sex at all, because you are not really interested in it. Besides that, your faith tells you not to have sex before marriage.

The set contains a mix of roles: some encourage to take risks and others to avoid risks. There are also some roles which leave it very much to the individual. The participants keep track of their encounters by writing down their respective partners on a contact card and noting whether they had no, safe or unsafe sex. There is a manual for the facilitator, usually the science teacher. The following describes what the facilitator may do.

**Suggestions and Strategies for the Facilitator**

The Introduction (5-10 minutes): Briefly explain the play and handout to all participants: (a) a role card, (b) a contact card, and (c) a beaker with “body fluid.” Carefully select the “seropositive” starter, who is not likely to be upset by a high risk role and is very well able to play the role of making passes. (S)he does not need to know that (s)he is the “seropositive” starter. Other roles should be assigned randomly to avoid stereotyping of students by the teacher. Allow the participants time to get themselves into their roles. Tell the participants to stick to their glasses all the time and to fill in their contact cards after each encounter.

**Encounters (15-20 minutes):** Give the go-ahead for the participants to start meeting each other. They will usually take some time to get to
know their partners. Do they choose sexual contact, then they have the choice of either safe or unsafe sex. Toasting their beakers with safe sex, exchanging fluids with unsafe sex. If they do not want sexual contact then they go their own way. After each encounter they fill in their contact card.

Testing (5 minutes): Stop the play and ask e.g.: Who thinks (s)he has been infected? And Why? Who thinks (s)he has not been infected? And why? Each participant’s beaker is now tested by one or two drops of iodine solution. The beakers with starch turn bluish, indicating infection.

Discussion (20 minutes): The facilitator discloses who the “seropositive” starter was, and facilitates the discussion by posing questions such as: Who had contact with this person? Who got infected? Who got infected, but did not have contact with the “seropositive” starter? How did participants manage to avoid infection? Do you go about it differently in your own life than in the play? It might also be interesting to try to trace the infection back to the seropositive starter.

The facilitator must feel at ease with the group as well as with discussions of sexual issues. The facilitator must be able to capitalize on the opportunities which the participants present in the group discussion. These opportunities may lie in further exploring issues such as power relations between the sexes, the role of persuasion, pressure and passion. Facilitators may want to make the classroom attractive by rearranging tables and chairs and by playing music from a cassette player.

Field Test Comparisons of Process and Content Between Different Countries and Subgroups

The role play was field tested in three countries. In Lesotho, the participants were from the post graduate certificate of education programme. In Botswana, the participants were secondary school pupils and members of the “Brigades,” teenagers and adolescents who combine work and vocational training for various trades. In the Netherlands, the participants were pupils from different levels in secondary education and trainees in Public Health Nursing.

Process

The process of the role play was remarkably similar in all countries and groups. Participants would initially be anxious or reticent. However, the ice was always broken within minutes and participants would actively engage in meeting partners. Participants joined the role play without exception, including students who, according to their teachers, were thought to be shy and withdrawn. This underscores that the role play was found non-threatening. Participants experienced the play as captivating and as great fun. They did not become disrespectful or vulgar. It was found that participants or groups who were younger and thought to have less sexual experience tended to spend less time on “chatting up” and courtship, while older students tended to spend a lot more time and effort on these aspects. In the group discussions, younger and less experienced groups, tended to discuss more their intentions about what they would like to do in future situations, while more experienced groups highlighted the difficulties in controlling situations in real life.

Content

As far as the content of the group discussion is concerned, some differences were observed. In the Netherlands, a number of participants pointed to the fact that they engaged in serial monogamous sexual relations. The play had made them realize, more than before, that partners may have their own sexual histories and that there is a risk of being infected. In all three countries, some boys received girls roles and vice versa (this is also a nice solution to the problem of having a rather unequal balance of boys and girls in a class). This raised a sharp awareness of gender issues. In a number of occasions in Botswana and Lesotho, women pointed out that, in real life as in the role play, they often felt that they could not refuse sexual advances, even if they did not really want to submit. At the same time, a number of men stated that they had never before so clearly felt the potential force of male pressure and its negative effects upon women.

In most groups, the potential for safe behaviour was discussed in some detail, both in terms of its practicalities (e.g., access to condoms at odd times of the night) and in terms of interpersonal dynamics. The latter included the importance of feeling self-confident, of trying to stay in control and of negotiating with your partner. In school classes participants often continued the discussions outside class hour and without the facilitator, sometimes off and on for a number of days.

Further possibilities for use of the role play

In science education, the role play may have additional value in highlighting mathematical issues,
such as simulations, risk and probability. In health care, the role play can also be used to illustrate epidemiological concepts, including the spread of disease, individual risk behaviour, interpersonal dynamics and risk situations.

Additional Note: The role play with a facilitator’s guide plus a few examples of role cards can be ordered from Rutgers Stichting, Postbus 17430, 2502 CK Den Haag, The Netherlands.

Students role playing in AIDS activity.

The International Conference
THE STANDARDS IN EDUCATION:
PROBLEMS AND PERSPECTIVES (SE-95)
9 - 13 October, 1995
Moscow, Russia

The Conference will be held on 9-13 October, 1995, at the International Center for Scientific and Technical Information in Moscow, Russia. The Conference is hosted by the Institute for General Secondary School (the Russian Academy of Education) and the International Center for Scientific and Technical Information.

The main topics of the conference include:

I. Standards of education (general topics):
   - standards and state policy on education;
   - purpose of educational standards;
   - functions of standards in educational process;
   - role of educational standards in democratization and humanization of education;
   - standards and certification of students and teachers.

II. Standards in mathematics and science education.

III. Standards in social studies and humanitarian subjects.

IV. Standards and assessment of the educational achievements:
   - methodology and technique of assessing the achievement of educational standards;
   - system of indicator and instruments.

Registration fee for participant, US $280; for student, US $140; for accompanier, US $100
For further information, you may contact by E-mail or phone to T.B. Zakharova: E-mail: zakh@inftech.iesi.rus Fax: +7-095-943-00-89 Phone: +7-095-198-7481 or +7-095-198-7320
LEARNING TO TEACH AND THE SCIENCE MUSEUM

Nancy Nagel, Ed.D
Charles Ault, Jr., Ph.D
Lewis and Clark College

Marion Rice, M.A.T.
Oregon Museum of Science and Industry

Beginning Our Collaboration
Lewis and Clark College and the Oregon Museum of Science and Industry (OMSI), in Portland, Oregon, have collaborated on numerous education projects since the early 1980's. The success of these projects, principally in support of experienced teachers, led staff at OMSI and Lewis and Clark College to think about developing an elementary level program for preservice teachers. Given the resources and reputation of OMSI, we chose to focus the program on science, mathematics, and technology education. Both institutions felt that developing and implementing a shared program for students preparing for an initial teaching position matched their goals and mission. We were interested in exploring new territory through utilizing museum experiences in the preparation of new teachers. This was a different venture than our prior experiences focusing on enrichment and enhancement for experienced teachers. A preservice teacher education program would provide a unique opportunity for each institution to share our collective strengths in the development of new teachers.

The existing elementary education program at Lewis and Clark College has a strong and well deserved reputation for a focus on "whole language" and thematic inquiry learning. Our goal in adding a new program or cohort (group of twenty students) was to preserve this model, yet modify the curriculum and experiences to capture the benefits from learning to teach in conjunction with science museum experiences and perspectives.

In the fall of 1991, Lewis and Clark College decided to hire an assistant professor of education to serve as coordinator of the new program. Staff from Lewis and Clark College and OMSI contributed to the job description and the interview process. All salary and benefits for this position are provided by Lewis and Clark College, and the College designated collaborating with OMSI staff in designing and coordinating the new teacher education program as a principle responsibility of this position.

During this same period, OMSI was expanding their role in teacher education. Over a ten year period, OMSI supported collaborative education projects with Lewis and Clark College in a variety of configurations. Murdock funding was obtained to support a half-time position at OMSI, with responsibility for coordinating graduate level science education courses and inservice teacher projects. When the funding cycle ended, OMSI continued the position, with funding obtained from NSF to implement a Teachers in Residence Program based at OMSI. The coordinator's position was advanced to Director of Teacher Education and, as a result of additional grant funding for technology and science education projects, a specialist position was added to assist the Director.

The program coordinator at Lewis and Clark College began her position in August 1992, working both at Lewis and Clark College and in an office space at OMSI shared with the Director of Teacher Education. Frequent discussions about goals and visions for teacher education helped clarify our
thoughts about education and set the stage for developing the new elementary preservice program. We knew we wanted to strengthen mathematics, science, and technology education, and we also knew we wanted students to be involved in an informal learning environment through the museum experience.

Lewis and Clark/Oregon Museum of Science and Industry Teacher Education Program

From these premises, planning began in earnest. We conducted interviews with teachers, administrators, and newly certified teachers. We read and discussed current educational reform agendas (American 2000, 1991; Holmes Group, 1986; SCANS Report, 1992). Frequent conversations reinforced our original thoughts about the need to improve mathematics and science education in the elementary grades. The program coordinator worked with college faculty, staff at OMSI, and local educators to develop and implement a sequence of coursework, network of school sites, utilization of museum resources and space, and shaping the role of the museum practica. By the early months of 1993 we had developed a 15-month graduate level teacher education program with an interdisciplinary approach to teaching and learning. The curriculum for the elementary education program, which began in June 1993, includes a 10-month practicum at a school site with a mentor teacher, a six-month practicum (one-half day per week) at OMSI, and education coursework.

The program was named the Lewis and Clark/OMSI Elementary Teacher Education Program and admits 20 students each June in a cohort format, with students moving through coursework and practica together. Many candidates hold undergraduate degrees in areas of science or mathematics or have had some experiences with outdoor schools, environmental programs, or summer science camps. Following completion of four consecutive semesters of coursework and practica (15-month program), students receive an initial teaching license and their Master of Arts in Teaching Degree.

OMSI Practicum

The focus on teaching and learning in the museum setting is a distinctive component of the program. We developed the OMSI practicum guided by the belief that sustained, first-hand experiences in informal science education at the museum would lead students to transfer this experience and create active, engaging learning environments in their classrooms. Science museums provide a unique setting, with children following their personal interests as they interact with an exhibit. Future teachers are well advised to pay close attention to the features of an informal setting that provoke and sustain interest as well as stimulate direct encounters with "the things of science" (Falk, Koran, & Dierking, 1986). From this perspective, the museum becomes a rich resource of teaching and learning models for transfer to the classroom setting.

During the first summer of the program, students enrolled in a Child Development course, located both in a classroom and on the floor at OMSI. Throughout the course, students observed child initiated interactions and following these observations on the museum floor, returned to the classroom and discussed their observations of how children were learning and what might be guiding their learning. This provided an extraordinary opportunity to immediately integrate theory and readings with practice, through observations and discussions. For example, when discussing Piaget’s theory of conservation, the students observed children investigating water and structures that move through water at OMSI’s “Engineer It” exhibit. Students watched the children gain new knowledge as the children manipulated objects in the water and explored density, speed, and maneuverability.

Because the science museum is a rich, informal learning environment, students have the opportunity to watch children in self-directed activities, with the freedom to explore, experiment, and interact among themselves. Discussions also focused on implementing lessons in classrooms that would enable children to be actively involved in learning as they construct their own meaning from the world around them. The purpose of these discussions was to facilitate the transfer of observations of informal learning made at OMSI to the classroom setting.

Additional summer practicum experiences included involvement in summer classes, Outreach programs, Whale Watch Adventure, and the OMSI Boys and Girls Clubs. Students were able to sample a wide range of science oriented activities and interact with children in these settings.

For the Fall semester OMSI practicum experience, students work in a science hall on a project for one-half day per week over a six month period. During the summer, students spent the first four weeks exploring the different halls at OMSI, beginning with an orientation to the museum and an introduction to each hall provided by the Hall Specialist. The Director of Teacher Education serves as coordinator of the practicum, working closely with the LC/OMSI Program Coordinator, the Lewis and
Clark Science Educator, and the Hall Specialists in designing optimal informal museum learning experiences for the LC/OMSI students.

Following orientation, students select a hall to work in and discuss project possibilities with the Hall Specialist. For example, several students chose to become involved in the Busytown Exhibit. The Hall Specialist asked them to observe children as they explored the exhibit and provide feedback about which activities seemed to be used most frequently and which activities needed revision. After several weeks of observing and note-taking, the students met with the Hall Specialist and discussed their observations. Changes were made to the exhibit based on the findings and information gathered by the students. Their next step was to work with OMSI’s Child Development Specialist to design curriculum that teachers could use prior to and following a visit to the Busytown exhibit. The curriculum was field tested in one of the student’s classes and was then incorporated as part of the materials accompanying this traveling exhibit.

The practicum experiences supported our original belief, that informal learning at the museum could be translated into classrooms. The students observed children interacting with the exhibit, discussed their observations with the Hall Specialist, designed curriculum for classrooms that was based on a museum experience, and implemented the curriculum with the children in their classroom. Indeed, these students experienced and created a strong connection between classroom-based instruction and informal learning at a museum.

Throughout the fall semester, students continue with their coursework, OMSI practicum, and begin their school practicum. As the OMSI practicum and school experiences are concurrent, students are able to relate their observations of learning in two different settings and discuss influences on children’s learning. The science and math education courses are held at OMSI, with OMSI staff participating in some of the sessions and students using the science museum to collect data or make observations related to the course topics. During a weekly seminar, students discuss their observations and experiences with teaching and learning and are encouraged to explore best practices in education, in both formal and informal settings.

**A New Dimension For The OMSI Practicum**

As we examine the OMSI practicum experience, we asked teachers, past graduates, and staff from OMSI and Lewis and Clark College to evaluate the practicum and make recommendations for next year.

The general consensus finds the LC/OMSI connection does support our initial belief: learning to teach while concurrently “learning about learning” in the science museum leads students to understand the importance of informal learning and how to construct a classroom environment that allows children to experience informal learning. All students in the first graduating class who were seeking teaching positions were hired. The number and quality of our admission applications have risen significantly, demonstrating a strong interest from students looking for a program with an emphasis on science, mathematics, and technology education through a museum connection.

One of the major OMSI practicum changes we plan is to hold a one-week special event at OMSI as a culminating outcome of the practicum experiences. In early December, the students will present their projects and interact with children from local schools. OMSI will advertise this event to the local schools as an opportunity for classes to be involved in science experiments, demonstrations, and short tours with future teachers. The students will share their knowledge about specific exhibits with the children along with designing and developing interactive activities for this special week. Revenue generated from the admission fees will cover costs for the Hall Specialists’ time with the interns, equipment, and materials needed for exhibits developed by the students, and other related expenses.

**Prospects for the Collaborative Journey**

We remain committed to working together to improve both education and teacher education by emphasizing the value and importance of informal learning and student-directed learning, as seen in science museums. For the past two years, we received Eisenhower funding to support the science, mathematics, and technology emphasis within the collaborative program. Financial concerns raise challenges, as the cost of accessing limited resources at both institutions must be paid. We anticipate that the admission fees for the “special event” week will raise sufficient revenue to pay for expenditures related to the OMSI practicum.

**School Collaborations**

The institutions involved in the LC/OMSI Elementary Education Program include public and independent schools, a college, and a science museum. Five schools representing inner city schools, suburban schools and an independent school continue to work with us in program design and student teacher (intern) placement. Staff from these schools assisted in the planning and continue to
provide input in ongoing evaluation of the program, along with participating in seminars for mentor teachers. We find the expertise of the mentors and the school administrators to be a critical program component and welcome the interactions and conversations about learning to teach. Their input has guided changes in the schedule, courses, and program requirements.

Parting Thoughts
If children learn best when constructing their own meaning from their experiences, then indeed informal learning such as that occurring in science museums is an important model to become immersed in while learning to teach. The rich, varied experiences that surround both children and the LC/OMSI elementary education students in the science museum encourage and promote the creation of classroom environments where children are actively involved in hands-on, meaningful learning on a daily basis.

References


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**ICASE AWARD SCHEME**

for outstanding contributions to international science education

Nominations for these awards must be forwarded by member associations of ICASE. For full details of how to forward nominations, contact the Executive Secretary below

**ICASE Distinguished Service Award**

This award is made to individuals who have a career history of distinguished service to international science education through their involvement in the international activities of local regional and global science education organisations

**ICASE Regional Service Award**

This award honours individuals who have made a significant contribution to international science education through their involvement in international activities at the local and regional levels

**ICASE Association Award**

This award recognises individuals who, within their science teacher association, have made a significant contribution to the international activity of their association

Contact Dr. Jack Holbrook, Executive Secretary ICASE
72B Blue Sea House, 28th October Street, Limassol, Cyprus
Resources

RECENT ICASE PUBLICATIONS

1. *The Status of Science-Technology-Society Education Worldwide*
   This 1992 ICASE Yearbook (140 pages), edited by Professor Bob Yager, University of Iowa, USA, has four sections: STS definition and rationale; Examples of STS initiatives; Evaluation of STS efforts; and STS in various countries.
   Price - £5.00 or $8.00

2. *Empirical research in chemistry and physics education*
   This book (195 pages) contains the papers presented in English at the biennial seminar on research in science education held in Dortmund, Germany, organized by Professor Dr. Hans-Jurgen Schmidt, in June 1992.
   Price - £5.00 or $8.00

3. *Problem-solving and misconceptions in chemistry and physics education*
   This is the latest in the series of biennial seminars on research in science education held in Dortmund, Germany in June 1994. The book (280 pages, in English) contains the papers presented at the seminar.
   Price - £8.00 or $12.00

4. *Sustainable development for a new world agenda*
   The World Environment, Energy and Economic Conference held in October 1990 in Winnipeg, Canada had as its main theme *Sustainable development strategies and the new world order*. The report of that meeting, with the main papers and discussion reports is now available as a major ICASE publication (250 pages), edited on behalf of ICASE by Professor John Penick, University of Iowa, USA. It contains a variety of viewpoints presented by specialists from many countries on the nature and complexity of problems associated with sustainable development and on educational strategies for introducing aspects of sustainable development into science curricula.
   Price - £10.00 or $16.00

5. *Education-Industry Partnerships*
   This is the report (125 pages) of the second ICASE European symposium, held in Arnhem, Netherlands in November 1992, on approaches to science education and industry liaison partnerships. The objective of the symposium was to strengthen the network of organizations and associations involved in industry-education links and to review the contribution of media and science centers toward the public understanding of industry and science.
   Price - £5.00 or $8.00

6. *Education in science and technology for development*
   This is a report (260 pages) of a conference held in Trinidad in 1991 on the theme of science and technology education for development—perspectives for the 21st century. There are three sections: Issues in education; Curriculum and educational strategies; and Science and technology and education.
   Price - £7.00 or $10.00

7. *Pasteur and Microbes*
   A teacher resource book commemorating the 100th anniversary of the Pasteur Institute 1888-1988.
   Price - £5.00 or $8.00

8. *Apollo 11*
   Price - £6.00 or $9.00

9. *History of ICASE*
   The 1993 Yearbook commemorating the first 20 years of ICASE.
   Price - £5.00 or $8.00

10. *Primary Science Source Book 1*
    This is the latest ICASE publication—for primary science teachers. It contains 50 photocopiable sheets of primary science activities from around the world with teachers' notes. There is a foreword by Wynne Harlen, Director of the Scottish Research Council.
    Price - £12.00 or $20.00
11. *Science in Space*
This book produced on behalf of ICASE by the Association for Science Education in the UK contains 10 units as resource notes for teachers who wish to present a variety of aspects of schools science within the context of space. The units are designed for students in secondary schools (age range 14-16 years), but trials in several countries have shown them to be of use with younger and older students as well as in general studies and social studies courses. Space and in particular the human view of space and space exploration can provide an exciting context for students studying science.
Price - £8.00 or $12.00

12. *ICASE Journal—Science Education International*
Published quarterly, the ICASE Journal is available at Price - £10.00 ($17.50) per year for individual subscribers. Postage is included. The Journal has sections devoted to Science Technology and Society, Science Teacher Education, Primary Science and Research in Science Education, as well as feature articles and general news items.

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**SCIENCE ACROSS EUROPE**

Many scientific issues, such as energy supply and water quality are of common concern yet perspectives as to their causes and resolution are different. This area of science, where common ground and different perspectives meet, provides schools with an excellent opportunity to stimulate teaching by taking the European dimension into account.

Join Science across Europe and your students can compare their findings with others all over Europe.

Science across Europe
- is a new way to help teach science, languages, and economics in an environmental context
- is easy to use
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- allows you to join a network of schools in over 20 European countries

For information contact Evelyn Van Dyk, The Association for Science Education, College Lane, Hatfield, Herts AL10 9AA, UK

(See article in this issue)
1995

August 27th-September 1st, 1995

Partners in Chemical Education
An International Conference on Industry-Education Initiatives in Chemistry
Location: University of York, York, UK
Contact: Miranda Mapleton
Chemical Industry Education Centre, Department of Chemistry, University of York, York, YO1 5DD, UK
Co-Sponsors: International Union of Pure and Applied Chemistry (Committee on Teaching of Chemistry) and Royal Society of Chemistry (Education Division and Industrial Division)

August 29th–September 2nd, 1995

The International Conference on Industry–Education Initiatives in Chemistry
Location: University of York, York, UK
Organisers: IUPAC Committee on Teaching of Chemistry
The Royal Society of Chemistry, University of York

The first major international conference sponsored by IUPAC which specifically aims to promote links and dialogue between concerned industrialists and teachers from higher education, secondary and primary schools, and educational decision makers; and to evaluate and encourage good practice and discuss issues of industry–education collaboration.

Correspondence/Conference arrangements:
Dr. J. F. Gibson
The Royal Society of Chemistry
Burlington House, Piccadilly
London W1V OBN
UK
Tel: +(44) (0) 71-437-8656
Fax: +(44) (0) 71-734-1227

September 4-15, 1995

Fourth World Conference on Women
Location: Beijing, China
Contact: Conference Secretariat: Division for the Advancement of Women, PO Box 500, A-1400 Vienna, Australia Tel: 431/21131, Ext. 4270;
Fax: 431/237-495 Media: Department of Public Information United Nations, Room S-1040 Tel: 212/963-1262; Fax: 212/963-4556

This conference will:
1) review and appraise the advancement of women since 1985 in terms of the objectives of the Nairobi Forward-looking Strategies for the Advancement of Women to the Year 2000.
2) mobilize women and men at both the policy-making and grass-roots levels to achieve those objectives.
3) adopt a “Platform for Action,” concentrating on some of the key issues identified as representing a fundamental obstacle to the advancement of the majority of women in the world. It will include elements relating to awareness-raising, decision-making, literacy, poverty, health, violence, national machinery, refugees and technology.
4) determine the priorities to be followed in 1996-2001 for implementation of the Strategies within the United Nations system.

September 24–29, 1995

CONASTA 44
Location: University of Queensland, Brisbane, Queensland, Australia
Contact: David Tulip, Centre for Mathematics and Science Education, Locked Bag No. 2, Red Hill, Queensland, Australia. E-mail: D.Tulip@qut.edu.au Tel: +64 7 864 3345 or Fax: +64 7 864 3985.

While the conference program is not finalised at this stage, it is envisaged that it will include thematic lectures, symposia based on science education and workshops either based on current science research or science classroom practices. All symposia and workshop sessions will allow for personal choice and will cater for Primary, Secondary and Tertiary science teachers and science teacher educators. Educational tours of the Great Barrier Reef, tropical and subtropical rainforest, whale watching and other unique geographical and biological features of Queensland, will also be offered three to seven days prior to or immediately following the conference. A detailed synopsis of the speakers, a framework of the conference activities and a call for abstracts of papers will be available by July 1994.
September 25-29, 1995

3rd European Conference on Research in Chemical Education
Location: Lublin (Poland)
Contact: Department of Chemical Education, Maria Curie-Sklodowska University, Pl.M.C. Sklodowskiej 3, 20-031 Lublin, Poland, dr Ryszard M. JANIUJK Tel: (81) 37-56-91 Fax: (81) 336-91 e-mail: JANIUJK@PLUMCS1

The previous two conferences were held in Montpelier, France in 1992 and in Pisa, Italy in 1993. The next conferences are planned to be held every two years. The conference in 1997 will be held probably in UK. The organizers of the conference are the Federation of European Chemical Societies and the Chemical Society of the country in which the conference is held.

October 9-13, 1995

International Conference: The Standards in Education: Problems and Perspectives (SE-95)
Location: Moscow, Russia
Contact: T.B. Zakharova
E-mail: zakh@inftech.icsi.su
Fax: +7-095-943-00-89 Phone: +7-095-198-7481 or +7-095-198-7320

October 1995

Women’s Conference
Beijing, China

1996

Industry-Education (ELF Sponsored)
Location: Paris

January 5-10, 1996

GASAT 8 International Conference
Location: Ahmedabad, Gujarat, India
Contact: Jayshee A Mehta
Conference Chair/Convenor
GASAT 8 Secretariat
SATWAC Foundation
A1/22, Amrapali, Sukhipura, New Shardamandir Road,
Paldi, Ahmedabad-380 007, INDIA
Tel: 91 79 428991, Fax: 91 79 416941

February 7-9, 1996

International Consortium for Research in Science and Mathematics Education (ICRSME) 6th Consultation
Location: Belize City, Belize Central America
Contact: Dr. Arthur L. White or Dr. Donna F. Berlin
The National Center for Science Teaching and Learning (NCSTL)
Room 100 Ohio State University
1929 Kenny Road Columbus, OH 43210-1015 USA
Tel: (614) 292-3339, Fax: (614) 292-1595

March 28-31, 1996

NSTA National Conference
Location: St. Louis, MO, USA

May 28-31, 1996

14th Dortmund Summer Symposium
Theme: Educational Research in Chemistry and Physics Education
Contact: Dr. Hans-Jürgen Schmidt
University of Dortmund, Dept. of Chemistry
Otto-Hahn-Str. 6
43221 Dortmund
Germany

The main aim of this conference is to discuss the methodology of empirical research in this field.

June 14-18, 1996

Science Centre Conference
Location: Finland
Contact: Ms. Helena von Troil, Secretary General Heureka, The Finnish Science Centre
PO Box 166
FIN-01301 Vantaa, Finland
Tel: +358 0 85799
Fax: +358 0 873 4142

The Association of Science-Technology Centres (ASTC) and the European Collaborative for Science, Industry and Technology Exhibitions (ECSITE) invite science centre professionals from all over the world to the FIRST SCIENCE CENTRE WORLD CONGRESS to be held at Heureka the Finnish Science Centre in Vantaa (Helsinki), Finland. The congress will give opportunities to learn and share the experience of colleagues from all over the world.
Internationally recognized experts will be invited to
give their views on education, science centres and
global issues. The programme will consist of several
parallel sessions. Sessions will be on aspects relevant
to the overall congress theme, such as:
- Providing memorable exhibits
- Influencing motivation in audiences
- Knowing your visitors
- Educational aspects of exhibits
- Catching the new wave technology
- Marketing an educational product

July 14-19, 1996

14th International Conference on Chemical
Education
Location: Brisbane, Australia
Contact: The ICCE Conference Secretariat
(Sally Brown), Continuing Professional Education,
The University of Queensland 4072 Australia
Tel: (07) 365 6360 Intl: +61 7 365 6360
Fax: (07) 365 7099 Intl: +61 7 365 7099
E-mail: chemed96@ceu.uq.oz.au

The 14th ICCE will be held in Brisbane from
July 14-19, 1996. It is only the second time this
conference has been held in the southern hemisphere.
The biennial conference brings together chemistry
teachers, chemists and science educators from school,
industry and university settings to share ideas and
learn from one another about innovation in teaching
and learning and the discipline of chemistry. The
theme, Chemistry: Expanding the Boundaries,
acknowledges the centrality of chemistry through its
expanding relationship with many facets of science
and everyday life. Conference participants will be
challenged to develop this theme with the view of
enhancing our understanding of the important
relationships which chemistry forms with the new
frontiers of human endeavour. Implications for
chemical education beyond 2000 which give a
"science for all" perspective will be encouraged.

December 27-30, 1996

NSTA International Convention
Location: San Francisco, CA
The convention, to be chaired by NSTA Executive
Director Bill G. Aldridge, will bring together
scientists and K-college science educators from
dozens of science and science education societies and
organizations worldwide. Invitations have already
been sent to societies in more than 30 countries.
Holding the event in San Francisco, it is hoped, will
especially encourage participation from Pacific Rim
countries.

At this convention, participating teachers and science
educators will present sessions in their areas of
expertise (interdisciplinary approaches are
encouraged) to scientists who are not as familiar with
the classroom. In turn, scientists will present sessions
about their work to nonspecialist scientists and to
educators less familiar with the latest news from the
research laboratory.

1997

South African Conference
Eastern Europe Conference
10th ICASE-Asian Conference
Location: Lahore, Pakistan

FOOD FOR THOUGHT

Why is it that scientific research uses
induction to create generalizable
rules while many teachers employ
deduction to teach it?

Ron Bonnstetter

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OPPORTUNITY FOR STUDENTS WORLDWIDE
ICASE WORLD SCIENCE ACTIVITY WEEK
22-28 OCTOBER 1995

SUSTAINABLE DEVELOPMENT

Activity Week Theme

The ICASE Project 2000+ Declaration states “...believe that scientific and technological literacy are essential for achieving responsible sustainable development”...assign priority to the development and introduction of programs leading to scientific literacy and technological literacy for all with the aim of achieving responsible sustainable development.”

ICASE encourages and supports projects in science and technology education in both formal and non-formal education. To this end ICASE offers a unique opportunity for Science Teachers’ Associations to involve teachers, who in turn may involve their students in formal or informal activities in exploring, within various cultural contexts, the concept of sustainable development.

Categories

The ICASE World Activity Week aims at involving:

• Primary/elementary level students ... ages 6-11 years
• Middle school/junior high students ... ages 12-15 years
• Secondary/senior high students ... ages 16-18 years

Activities

Student individual/group entries may be of three types:

1) Poster or cartoon, paper size not to exceed 220 mm x 300 mm, in single or multiple frame format (applies to all grade/age categories). Poster or cartoon to focus on a sustainable development issue.

2) Essay/paper supported by illustrations/photos focusing on a community sustainable development issue:
• Primary (up to 250 words)
• Junior (250-500 words)
• Senior (1000-1500 words)

3) Investigation activity which highlights a sustainable development issue. Students prepare a report focusing on the far ranging implications of the activity (applies to all levels).

Awards

Certificate awards will be available to each ICASE Regional Representative who, with an appointed panel, will evaluate the entries and recognize up to 20 individual/group entries across all categories. One special award/prize per ICASE region will also be made across all categories. A final report will highlight entries and summarize awards stimulated by ICASE World Activity Week.

ENTRIES . . . Deadline 30 December 1995

Entries may be submitted in Spanish, French, or English and are to be directed to the ICASE Representative in your region:

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Australia-Pacific: M. Silis, University of South Australia, Smith Rd, Salisbury East SA 5109, Australia
Europe: A. Wojtyn-Jodko, SNPPIT, Skrytka Poczta 62, PL-85791, Bydgoszcz, 32, Poland
Latin America-Caribbean: J. Chamizo, Colegio Madrid AC, Calle Puente 224, 14380 Mexico DF, Mexico
North America: K. R. Roy, Glastonbury Public Schools, 330 Hubbard St., Glastonbury CT 06033, USA

. . . award winners will be announced in March 1996 . . . entries become the property of ICASE and will be displayed or put in print in ICASE publications.

For Further Information:
Mr. Bob Lepischak, Convenor, 1995 ICASE World Activity Week, PO Box 430, Neepawa Area Collegiate, Neepawa, MB, Canada R0J 1H0, Fax (204) 476-3606.
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Science Education International is the Quarterly Journal of the International Council of Associations for Science Education. ICASE was established in 1973 to extend and improve education in science for all children and youth by assisting member associations throughout the world.

This journal provides a means for associations, institutions, centres, foundations, companies and individuals concerned with science education, to share perspectives, concerns, ideas, and information which will foster cooperative efforts to improve science education, and which will serve as a chronicle of the advancement of science education throughout the world.

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ICASE News
ICASE Distinguished Service Award 2
The International Baccalaureate Organisation 2
Project 2000+ —Report of a Visit to Vanuatu 3

Feature Article
Constructivism For Science Teachers 5

Editorial
What is "Beyond Science-Technology-Society" (STS)? 13

Science Education Around the World

Research on Curriculum, Teaching & Learning
How Can We Communicate the Results of Educational Research to Practitioners? 21

Teaching Materials & Strategies
Using Overhead Transparencies in Guiding Students' Cognitive Activities in Chemistry Class 25

Science Teacher Education & Leadership
A Long Soak Followed by Reports of Intensive Swimming: A Tale of Inservice Cooperation Between the Philippines and Australia 27

Assessment and Evaluation Trends
Was I Supposed to Know That? Teacher Understanding of Science Safety Issues 33

Calendar 39
ICASE DISTINGUISHED SERVICE AWARD

The ICASE Distinguished Service Award was presented to Professor Dr. Hans-Jurgen Schmidt of the University of Dortmund Germany by ICASE Honorary Treasurer, Dennis Chisman, during the German Science Teachers' Association (MNU) annual meeting in Nuremberg on 10 April 1995.

Hans-Jurgen Schmidt was the European Regional Representative on the ICASE Executive Committee from 1981 to 1985 and has been the organiser, since 1981, of the Dortmund Summer Symposia on research in science education held, in cooperating with ICASE, every two years. He has represented MNU at many international science education meetings and has particularly encouraged the development of science teachers' associations in Europe. He has contributed papers at many international conferences on the role of research in science education and has written many articles in science education journals on the role of research in promoting more effective classroom practice in the teaching of science.

The proceedings of the most recent Dortmund Symposium, in 1994, edited by Hans-Jurgen Schmidt is entitled Problem-solving and misconceptions in the teaching of chemistry and physics (available from ICASE at $12 or £8). The next symposium is scheduled for 28-31 May 1996.

THE INTERNATIONAL BACCALAUREATE ORGANISATION

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The IBO provides a Diploma programme, primarily for 16-18 year old students, which is an internationally recognised university entry qualification. The IBO also offers the Middle Years Programme (MYP) for students aged 11-16 years.

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The main headquarters of the IBO is in Geneva. Curriculum and Assessment activities, including curriculum development work, examination paper preparation and grade awarding, are carried out in Cardiff, South Wales. There are Regional Offices for North America and the Caribbean (New York), Europe/Africa/Middle East (Geneva), Asia Pacific (Singapore) and Latin America (Buenos Aires). These are complemented by sub-regional offices in Sweden, Australia, Mexico, India and Japan. Further basic information about the IB Diploma or the Middle Years Programme can be obtained from the IBO by writing to:

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PROJECT 2000+ – REPORT OF A VISIT TO VANUATU

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Introduction
The aim of Project 2000+ is to promote scientific and technological literacy (STL) for all people in all countries. The Republic of Vanuatu (formerly the New Hebrides) is a group of about 80 islands some 400 km north-east of New Caledonia and some 800 km west of Fiji. The islands are mostly volcanic in origin and the population of about 150,000 is largely Melanesian. Before gaining independence in 1980, the islands were administered as an Anglo–French condominium. As a result of this, approximately half the schools use English as the medium of instruction, and half use French.

My brief for the visit, from 30 June to 7 July 1995, was to:

• promote awareness of Project 2000+ amongst appropriate personnel in the formal and non-formal sectors in Vanuatu.
• promote debate of STL in Vanuatu, and stimulate initial discussions aimed at identifying desirable projects/activities and the means to implement them.
• identify appropriate institutions and individuals with whom international organisations such as UNESCO and ICASE might communicate regarding, for example, regional activities under the auspices of Project 2000+.
• participate with teachers in a short workshop to develop examples of teaching and learning materials for STL.

This brief is in line with ICASE’s policy of promoting Project 2000+ and, in particular, of helping to facilitate the training of science educators in the development of STL resource materials which are appropriate to local needs and circumstances. ICASE therefore saw the Vanuatu visit as a useful pilot exercise and were successful in obtaining financial assistance from the Commonwealth Secretariat on this basis. The teachers’ workshop was organised by the Vanuatu Ministry of Education with financial support from the New Zealand Educational Assistance Programme. Some of the materials used at the workshop were provided by Questacon, Australia’s National Science and Technology Centre.

Pre-Workshop Discussions
In the two days before the workshop, I tried to meet as many as possible of those concerned with education in both the formal and non–formal sectors. All of my contacts were supplied with documents relating to Project 2000+ in either French or English, including the Project 2000+ Declaration. They were also advised of the role of ICASE, both generally and in promoting the project.

In both sectors, the most interesting discussions centred around the interaction between local cultures and those aspects of science and technology which increasingly affect the lives of island communities. Three barriers to the successful integration to the two cultures became apparent:
the need for, or desirability of, the changes introduced was not always truly accepted by the community decision makers;

- communities often felt no sense of ownership for new technologies (especially when these were introduced by outsiders);
- lack of relevant understanding, skills and attitudes often prevented communities from making effective use of, and from properly maintaining, new technologies.

The introduction of pumps to supply water in isolated island communities provides a good illustration. In similar small island communities in Britain, for example, if the pump breaks down almost anyone in the community will immediately try to fix it – and will usually succeed. If not, the professionals will be called in and the matter rectified without delay. In Vanuatu, on the contrary, nothing at all may be done for some considerable time! Eventually “Public Works” may be informed. After only a few years, the pump may become defunct. The British community places a high priority on the clean water provided by the pump. It is perceived as part of their own technology and even someone with no particular training in its maintenance probably has sufficient know-how, confidence and initiative to try repairing it. In the culture of Vanuatu, the decision makers are the senior men of the community and they may not greatly value the pump at all. After all, they can obtain the water they need by simply sending the women to fetch it in buckets, as they did in the past! They may not appreciate the difference which the pump makes to the quality of the water and the quality of life of the women, nor fully understand the importance of both to the health of the community. They may see the pump as not really belonging to their own way of life and therefore feel unwilling to do anything about it when it breaks down. In any case, their culture has not prepared them with the understanding, skills and attitudes which would give them the confidence to try fixing it, so they are dependent on outside help.

In the Ministry of Education, my discussions focussed mainly on the implications of Project 2000+ for Basic Education. In Vanuatu this covers both primary and junior secondary schooling. Almost all children attend primary school (years 1 – 6) but only about 20% at present proceed to junior secondary (years 7 – 10). Of these, again only about 20% go on to senior secondary schools, where about half will specialise in science. It was encouraging that all concerned accepted the notion that the science and technology included in basic education should arise naturally out of the actual needs and interests of island communities, and should not be dictated by the demands of higher education for a small minority. However, it was conceded that the needs of future science students could not be neglected in the junior secondary curriculum.

Those responsible for administration and finance within the Ministry were also contacted and were very supportive. They pointed out the importance of involving them at the earliest possible stage when particular activities were being proposed under Project 2000+. This would greatly facilitate their efforts to obtain the administrative and budgetary resources needed.

Although Vanuatu is a small country, it proved difficult in the short time available to get a good overview of what was happening in the area of non-formal education. Quite a number of church and community groups, as well as NGOs and Regional Organisations, are engaged in projects which include rural or community education. In the case of the Presbyterian church, many of these projects are associated with vocational training and appropriate technology. They have, for example, worked with local communities to develop water pumps, water tanks and more than one kind of cooking stove. In addition to more local efforts of this kind, the Federation for the South Pacific is involved in community education, and the UNESCO Regional Office have programmes promoting basic education and life skills in the community as well as the training of primary school teachers in the formal sector. The Environmental Education Awareness Project of the South Pacific Regional Environmental Programme (SPREP) is another regional initiative which involves training activities in both the formal and informal sectors. With so many organisations involved, there would be obvious advantages in mutual co-ordination and the sharing of experiences. This may already happen to some extent, but it was clear that only a minority of those I met were well informed regarding the activities of other programmes and groups. In this situation it was not immediately clear how Project 2000+ might best become engaged in the non-formal sector.

I also called at the Vanuatu Cultural Centre where I met the Director. He expressed great interest in the ways in which science and technology are already interacting with local cultures in Vanuatu. He also drew attention to the importance, when planning curricula for both non-formal and formal sectors, of considering the place of traditional medicine and “magic” alongside modern scientific notions. He was already aware of the work of Questacon and of their hopes to bring their popular “Fascinating Science” programme to Vanuatu. Although such a visit would probably be coordinated
through the Ministry of Education, I expressed the hope that it might act as both inspiration and opportunity for the Cultural Centre to develop interactive exhibits consistent with its own mandate.

**The Basic Science Teachers’ Workshop**

The workshop lasted four days and was attended by 40 full-time participants. These were mainly junior secondary science teachers who represented 19 schools on 10 different islands. There were also two staff each from the Curriculum Development Centre and the Vanuatu Teachers’ College. In addition to these, various interested people attended selected sessions.

The objectives of the workshop were to –

* raise participants’ awareness of Project 2000+ and promote active discussion of STL for all;
* familiarise participants with a hands-on, interactive approach to learning science;
* give participants experience of developing teaching and learning materials consistent with such an approach and appropriate to local circumstances;
* enable participants to contribute to on-going renewal of the science curriculum.

The workshop was opened by the Honourable Minister of Education who expressed his strong support for the notion of STL for all in Vanuatu. The opening was reported on Radio Vanuatu.

After a short session to deal with administrative matters, the workshop moved into top gear with a major presentation regarding Project 2000+. This was delivered in the local pidgin, Bislama, one of the official languages of Vanuatu and well understood by both the English and French speaking teachers. It was supported by a large number of slides which were projected simultaneously in French and English. The origins and aims of the project were discussed and the proceedings of the International Forum on STL for All, held at UNESCO, Paris in July 1993, were reviewed. The importance of gender issues in the context of STL for all was particularly stressed. This rather lengthy presentation was broken up by two short interludes which attempted to bring home to participants the drastic nature of the world population explosion. It was followed by a short video illustrating the sorts of environmental degradation that can result from the unwise importation of inappropriate technologies and the over-exploitation of natural resources.

On the second day, the participants broke up into small groups to discuss the meaning and implications of STL for all in Vanuatu. These sessions evoked some very animated and fruitful discussions. The need to make science and technology more relevant and more accessible to women and girls was particularly highlighted. In the afternoon, the groups tried out and evaluated six different "Exciter Packs," developed at, and kindly donated by, Questacon. These packs contain hands-on science activities suitable for use with children up to the age of about 12 years. The teachers all had plenty of fun with the packs which clearly generated a lot of enthusiasm. A short video about the work of Questacon completed the day's work.

The third day started with a discussion of some ways in which Vanuatu might start to become involved in Project 2000+. One francophone and two anglophone groups produced short written reports which were then consolidated as a basis for further discussion during a plenary session on the final day. The remainder of the day was devoted to developing, again in small groups, hands-on activities suitable for Vanuatu children using the "Exciter Packs" as a model. Themes selected by different groups included Heat, Air Pressure, Water, Environment, and Tins! Within each theme, groups developed two to five activities using cheap, locally available materials. Each activity had to include simple instructions for the children and an explanation of the science underlying the activity. On the morning of the final day, each group displayed its activities on a separate table and then moved around trying out those produced by other groups. Although most of the activities still required further development, this generated so much enthusiasm that teachers and pupils from a nearby primary school were invited to come and see an impromptu exhibition during the tea break. This was enjoyed by all, and indeed a few of the participants were so busy demonstrating their activities to groups of children that they missed their tea altogether!

Perhaps inevitably, not many of the activities were particularly original, although the materials used and the presentation often were. One or two, however, are briefly described below as examples. Two ladies in one group produced a working model of a cooking stove using discarded materials. This used only sawdust packed into an old tin. A hole was cut into the side of the tin near the base. A short stick of sugar cane was inserted through this hole and a longer one was held vertically in the centre of the tin while it was packed fairly tightly with the sawdust. The two sugar canes were then removed, leaving a passage from the air inlet at the base leading to a vertical flue through the packed sawdust. After lighting a few twigs inside the inlet, the sawdust catches fire and burns slowly in the air draft created by the flue. Several tins of water were boiled on this during the workshop. In addition to exemplifying the
local appropriate technology on which it is based, the stove provides an excellent illustration of convection and various aspects of combustion; for example, it quickly goes out when the air inlet is blocked!

Another interesting idea, also designed to show convection, took advantage of pupils’ natural interest in the volcanoes which are a feature of the landscape on many islands. It was based on a hollow “volcano”, made of plasticine or clay, in a container of cold water. This was placed on top of a container of hot water which had been coloured by ink. The inky water was intended to rise through the hole in the top of the plasticine volcano. Because of the short time available during the workshop, the model produced still had some problems at the interface between the hot and cold water and in reliably establishing the convectonal circulation in the required direction! Given more time, however, these would surely be overcome to produce an attractive, instructive and appropriate demonstration.

The last session of the workshop was devoted to a plenary discussion of proposals drawn up following the group discussions on the third morning. Final recommendations, which were forwarded to the Ministry of Education, included:

- Review of curricula at basic education level (to include technology as well as science, to be based on the experiences, needs and interests of the community and not on the demands of secondary education, and to employ flexibly many hands-on activities for pupils);
- Training and use of junior secondary science teachers to run in-service courses and materials development workshops for primary school teachers in the islands;
- Coordination of overlapping efforts involving various regional and local groups as well as the Ministry of Education, and the non-formal as well as the formal sector;
- Appointment of a permanent science education adviser (with appropriate qualifications and experience in both science and basic-level education) to spearhead the above efforts;
- Formalisation of the Science Teachers’ Panel (by appointing a committee and drawing up a constitution) so as to facilitate interaction with overseas science education organisations including ICASE.

Before leaving, participants were asked to complete a short evaluation form which contained both closed and open-ended questions. About two-thirds of the respondents said that the workshop had been very successful in achieving all of its objectives, while the remaining one-third said that it had been moderately successful. They also expressed particular enthusiasm for doing and developing hands-on activities, for all the sessions which involved discussing and working together in small groups and for the final plenary session at which recommendations for further action were drawn up. My own impression too, was that the workshop went well and that most of the participants were interested and involved throughout. Although many had little previous experience of working together in small groups, this appeared to be an effective, as well as popular, strategy. Opportunities for individual contributions were maximised and participants clearly enjoyed and benefited from the sharing of ideas which took place. Perhaps more time might have been allowed for the presentations and discussions which followed most of the group work, however I regarded the process of thinking about and discussing the implications of STL for all, as more important than reaching any particular and final conclusions at this early stage of the project.

**Some Reflections on the Visit**

As mentioned in the introduction, ICASE regarded this visit to Vanuatu as a pilot exercise. It therefore seems appropriate to reflect on what might be learnt. First, then, I would like to emphasise the value of the pre-workshop discussions. Not only did these provide excellent opportunities to promote Project 2000+ in the appropriate quarters, and identify those most likely to become involved in implementing it, they also proved a valuable source of ideas and inspiration for the workshop itself. Perhaps the most interesting aspect of this, was the way in which the idea of helping communities to bring relevant scientific and technological ideas within their own cultures, gradually took over from the notion of scientific and technological literacy as such.

In regards to the workshop, the number attending was well in excess of expectation. This had both positive and negative outcomes. On the positive side, the presentations and discussions involved more people in thinking about Project 2000+ and its implications for Vanuatu. However, during the sessions devoted to the development of teaching and learning resources, it was difficult for so many participants to receive the individual help they needed. Thus, although many promising activities were certainly produced, all but a few still required further improvement to make them suitable for classroom use. In particular, greater individual help might have succeeded in encouraging greater originality and improving the quality of the written materials which accompanied each activity.

Generally speaking, the instructions to pupils were
adequate, but the explanations of the underlying science were less so.

As regards the planning of future workshops, I believe that the numbers attending should be limited to about 20 of the best and most committed teachers. A few additional staff from the curriculum development and teacher training establishments could also be involved and could have a dual role, assisting the team leader as well as participating. The next workshop should also be more sharply focused and more product oriented. It might, for example, be directed towards the revision of the primary school curriculum, or the production of hands-on activities to cover particular topics or process skills, or the intensive training of selected teachers to run courses for primary school teachers or rural communities. Indeed, all of these activities would be worthwhile and are likely to be needed at some stage before the year 2000.

A particularly valuable feature of the workshop was the decision to put forward recommendations regarding the implementation of Project 2000+. The importance of curriculum review at the basic education level, and for this to reflect community needs in technology as well as science, was accepted by all I met. If one also accepts the notion of fostering the adoption of appropriate science and technology into local cultures, and the fact that as many as 80% of pupils do not at present progress beyond class six, it may be that the formal sector should borrow curricula ideas from the non-formal, rather than vice versa! Indeed much could be gained through improving communication between the formal and non-formal sectors, and between the many different groups which are making significant inputs to both. The SPREP Environmental Education Awareness Project, for example, has budgeted for two extended teachers' workshops to carry out, in the more limited field of the environment, almost exactly the same training and tasks as those just undertaken at our own basic science workshop. Teachers told me that, in the past, lack of adequate liaison at the professional level has led to confusion in the minds of those who have attended workshops or gained by different bodies. These have sometimes presented very different messages and it would obviously be desirable to avoid this sort of confusion in the future. Certainly the idea of training junior secondary school teachers as resource persons has much to commend it. Their schools are well scattered throughout the main islands and, with suitable support, they are well placed to liaise with those working in community education projects and to help primary school teachers to develop and use locally appropriate learning activities with their pupils.

Any new initiative requires leadership from the right person in the right place. Probably in common with many small countries, Vanuatu does not at present have anyone well placed to pursue the challenge of implementing Project 2000+. There are no professional science educationists in the Ministry of Education itself, and those having nominal responsibility for science in the curriculum development and teacher training institutions, have primary responsibilities in other subject areas which take up most of their time. Unless the importance of science and technology in basic education is recognised by the appointment of at least one suitable person to a suitable post, it is difficult to see where either the drive or the expertise necessary to achieve the aims of Project 2000+ is likely to come from. Similarly, science teachers need to open channels for professional communication if they are to benefit by exchanging ideas and information with those engaged in the same enterprise all over the world. The formalisation of the structure of Vanuatu's science teaching panel was recommended by the workshop explicitly to facilitate such communication with appropriate international organisations.

In conclusion, I would like to take this opportunity to express my thanks to ICASE for their help and encouragement in arranging for the visit and to the Commonwealth Secretariat in London for paying for my travel and my subsistence. I would also like to thank the Ministry of Education for inviting me, all those in Vanuatu who gave their time to organise everything, to meet me, and to share their views with me, and finally all the participants in the workshop for their good humour and hard work.

David Slimming was a Science Education Adviser with the British Council for more than 20 years and has worked in many different countries in Africa, Asia and the Pacific. He now undertakes consultancy work from his home base in Canberra.
Feature Article

CONSTRUCTIVISM FOR SCIENCE TEACHERS

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Constructivism is a concept that in recent years has garnered considerable attention among science education researchers. Essentially, it is a model or metaphor of how learning takes place. Prominent science educators have called it a most promising model and a theoretical shift that may lead to a coalescing of current thought as well as the stimulation of new ideas. I do not believe this is hyperbole. The potential significance of constructivism has already extended beyond research and into the science classroom. References to constructivism appear ever more frequently in the literature, however, often with little or only trivial discussion of the philosophical meaning of constructivism. My purpose in this article is to acquaint teachers with the philosophical roots of constructivist thought enabling them to better understand this expanding literature. First, however, it is necessary to offer a word or two about Piagetian cognitive development theory which has dominated educational thinking for some years now.

The Eclipse of Piagetian Theory
Piagetian cognitive development theory has precipitated enormous amounts of educational research. However, an inability to translate research findings into practice has been a chronic weakness of Piagetian theory. Joseph Novak, an eminent professor of science education, wrote that for years he had been "trying to suggest that the Piagetian paradigm for cognitive development is not the most useful paradigm to guide research in science education nor for planning instructional programs" (1978, p. 591). His arguments remain appropriate. Moreover, cognitive development theory has never quite escaped the charge that it is culturally biased. The difficulty with cognitive development theory lies in a paradoxical relationship between rationality and understanding. Piaget designed a set of clinical interviews based on formal propositions of logic. He inferred levels of cognitive development in terms of rationality from performance on interview tasks. By inference, a person who successfully completes the tasks is able to handle advanced propositions of logic, and therefore, is capable of learning advanced subject matter. To use the jargon of research on reasoning, this person is a rational, logical thinker who uses formal, abstract operations. For use in education research, educators derived from Piaget's clinical interview procedures several paper-and-pen assessments of rational development which can be used with large numbers of students at one time. This latter type of research is typically called research on cognitive development and is the focus of the next comments.

It strikes one's attention when reading the literature in education on cognitive development research that so many studies find that many secondary students and even adults have not reached abstract or formal levels of logic. The research seems to say that many secondary students and adults fail to understand science because they simply have not attained a high enough level of rational thinking. I find this problematic. Clearly the cognitive development researcher must assume that the premises of the assessment procedures are correctly understood by the person being assessed. That a person understands a task or statement, however, can only be determined by observing that the person agrees or disagrees as to (a) what statements are the same as the given one, (b) what the given statement implies, (c) what other statements are contradicted by the given statement, and (d) what is irrelevant to the given statement (Smelser, 1970). This is exactly where the difficulty lies. If a person cannot think well (if a person is not very rational) that person will not be able to recognize statements that are equivalent in meaning, statements that contradict each other, the implications of a statement, or the things that are irrelevant to the presented statement or problem. Then, if the subject fails to answer the test or interview question properly, the researcher is actually unable to determine whether the subject failed due to a lack of logical skill or due to a failure to understand
the premises of the task. The point is that in ordinary situations it is exceedingly difficult, if not impossible, to separate rationality from comprehension. The cognitive development researcher can only proceed by assuming that a subject understands what is going on in the test. But, this is a counter-intuitive and counter-factual assumption. "In conversation we always assume that the other person is logical . . . When our expectations are not fulfilled, we normally attribute it to a lack of understanding . . . but not to genuine illogically on his part . . . logic must be presupposed, since it is characteristic of any activity of any integrated system and is a part of the very notion of a person (Smidslund, 1970, p. 217-218). Smidslund's point is that the researcher is making an assumption that defies common sense. We have a very well established precedent from everyday life: when a person does not get a thing correct, we don't assume he lacks logic. We assume he has failed to understand and thus we proceed to try another approach to explaining the thing.

The question in education is why would we want to abandon an approach that has served daily life so well? The answer that people give is that children are different. Surely children are at a lower level of rational thinking than adults regardless of what is assumed about understanding. On this premise educators have written what they argue are developmentally appropriate curricula which prescribe what topics can be taught at various ages. Indeed, few would disagree, for example, that the concept "chair" is less abstract than the concept "atom," and therefore more readily understood by young children. But how is it that the concept "atom" is more abstract than the concept "chair?" In cognitive development theory the answer is that acquisition of this concept requires advanced rational thought that children have not yet attained. However, it is also true that "atom" and "chair" are not epistemologically equivalent concepts. A conceptual analysis of "atom" reveals that this concept is built up from a large number of other concepts. In other words, the concept "atom" subsumes a large number of related concepts. Grasping the concept "atom" requires a grasp of the subsumed concepts. In contrast, the concept "chair" subsumes far fewer related concepts, and thus, grasping the concept "chair" requires the grasp of fewer related concepts. Is then the concept "atom" more difficult to understand because its understanding requires an advanced level of rational thought? Or, is it difficult because of the sheer number of subsumed concepts that must be grasped before one can understand the concept "atom"? In the later case, the young child simply has not lived long enough or has not had the requisite experiences needed to build up the prior knowledge necessary for understanding a difficult concept such as "atom." It is not clear that children's thinking differs from adult thinking because children are less rational, rather than because children have less developed conceptual frameworks.

This issue of understanding versus rationality has great importance for the classroom. If the teacher assumes that (say) elementary children are rationally unable to learn certain concepts, the teacher will not teach those concepts. In first grade one teaches about animals, but not about atoms. At first glance it appears that the ability to offer teachers a developmentally appropriate curriculum is a good thing. Unfortunately, such a curriculum can easily put the brakes on teaching. In a developmentally appropriate curriculum, the tendency is to not press beyond a given topic even when that topic has been successfully taught, because the curriculum implies that the teacher should go no further than the prescribed appropriate concepts. Common sense tells us that success should be a stimulus for further efforts regardless of difficulty, and that the teacher should simply keep going as long as the children are learning. This is exactly what a competent teacher does when the teacher's focus is understanding rather than rationality and cognitive development. Thus, even if one accepts that children are at lower levels of rationality than adults, the value of the influence of cognitive development theory on curriculum is debatable at best.

Cognitive development theory is used to inform instructional practice as well as curriculum, but it is not the stage development aspects of the theory that are used. Instructional practice is informed by Piaget's concepts of accommodation and assimilation. These concepts are clearly about understanding, not rationality. David Ausubel (1968) has demonstrated that the concepts of accommodation and assimilation do not have to be linked with developmental stages. His focus has been to develop a theory of meaningful learning that extends the concepts of accommodation and assimilation rather than switching to concepts of rationality. One of Ausubel's chief ideas is that only personally meaningful learning is true learning. His recognition of the powerful influence that prior learning has on the meaning a student makes of any learning situation sets the stage for constructivism.

The focus of constructivist theory is understanding. In my view, this is one of the primary reasons that constructivism is rapidly replacing cognitive development theory as the foundation for science education research and practice. Moreover, one the attractions of constructivism is its utter simplicity. On reflection, one would almost say the
notion is patently self-evident. However, the widespread adoption of the term constructivism has actually created considerable confusion and controversy. For all its simplicity, the term seems to mean different things to different people. Constructivism for some is a rather uncomplicated, pragmatic description of learning that can be turned about and used to guide teaching. For others, constructivism is more a philosophy about knowledge. Those with the more philosophical orientation (they are known as radical constructivists) argue that it is fundamental that cognition is a biological adaptation that serves to organize experience for a person but it does lead to the discovery of how things really are (Glaserfeld, 1989). So what is constructivism?

The Uncertainty of Knowledge

In an effort to foster an intuitive grasp of this concept, I prefer not to start with a definition. Rather, what follows is a descriptive narrative. I trust that the narrative, in somewhat inductive fashion, will evoke in the reader an understanding of constructivism prior to hearing a formal definition.

We all wish to know about the world around us, whether we are speaking of the world in physical, social, or even spiritual terms. Science, of course, is the discipline that tells us about the physical world, and in science one’s senses are critical. One uses sight, hearing, feel, and taste to learn about physical phenomena. Instruments are used to extend the range of the basic human senses. These instruments can be as simple as an ordinary ruler or as complex as a radio telescope or mass spectrometer. Typically, what we have thought in science is that our senses provide authentic data about the real world. Experimentation keeps subjectivity in check. But is that really how our senses work? Consider that science uses the senses to focus only on what can be measured. For example, a scientist typically is not as interested in the color of an object as he or she is in measurable electromagnetic wavelengths emitted or reflected by the object. If you want to build a color television, knowledge of electromagnetic wavelengths is necessary. However, who can say that a wavelength of $4.0 \times 10^{-7}$ meters tells us any more about the reality of an object than does blueness? In fact, philosophers of science tell us that the question cannot be answered. Scientists focus on measurable attributes simply because they have chosen to do so—it works for what they want to do.

There is another question that confronts our attempts to understand reality, regardless of the physical attributes on which one chooses to focus. How do we know that what we perceive is what is actually there? As early as 1604, Kepler demonstrated that the physical image on the retina of the eye is actually inverted. Yet that is not how we perceive objects. We perceive them right side up. In other words, even though we see an object upside down, we nevertheless perceive it right side up. So how can we say that what we see is actually what is there? Perception appears to involve interpretation rather than simple transmission. To further illustrate the difference between sight and perception, try to image a person born without functioning sense organs. Somehow the person survives and one day after many years, the person’s eyes suddenly start functioning. His eyes would see reflected light just as ours do; but, what would he perceive? A mass confusion of light, a jumble of hues and intensities, a tumult of sensation, all signifying absolutely nothing. He would not recognize a tree in front of him because he could not have had any prior knowledge of the concept of tree. Perception is the act of one who sees, not the passive reception of light reflected by objects. To make this more personal, imagine that you have just removed the cover of your personal computer. Few of us know anything at all about the physical apparatus within a computer casing. Open one up and what we perceive is a confusion of lines, shapes, and colors—signifying nothing. On the other hand, the computer scientist perceives a computer. This illustrates what the modern developments in the philosophy of science have clearly shown, all observation is theory laden.

There are then two profound limitations on scientific knowledge. First, science is limited by its focus on selected attributes to the exclusion of others. This is a choice made by scientists, not a limitation imposed upon science by physical reality. Second, one can perceive an object only when one has preexisting knowledge of what is being examined. The result is that the scientist can never say that he or she has exact knowledge of what reality is like. Rather, the scientist drawing upon previous knowledge interprets experience following rules agreed upon by the community of scientists. A scientist constructs knowledge to fit experience. Instead of a photograph of reality, scientific knowledge is much more like an artist’s impressionistic painting of reality. The notion that knowledge is constructed leads some to conclude that all knowledge is inherently subjective. Others take the more conservative position that knowledge can be objective but that all knowledge is fallible.

This essentially means that scientific knowledge is fallible, and this has implications for education. If there were a direct link between the scientist and a physical reality independent of the scientist, one
could argue for a direct link between scientific knowledge independent of any knower and the acquisition of scientific knowledge by a learner. This is the viewpoint of naive objectivism. It implies that knowledge can have an existence independent of a knower. It thus implies that the best way to teach is by careful, methodical, detailed explication of scientific knowledge with the expectation that students will learn by receiving (i.e., memorizing) the knowledge. In fact, under the influence of positivism which taught that rationality and objectivity resided in quantitative experimental science, that is exactly how science has been taught for many years. However, if scientific knowledge is a scientist’s meaningful construction based on his or her experiences of reality, how can the learning of scientific knowledge be any different? If I cannot know reality for sure, what is it that I am learning when I learn? Essentially, there is no difference between the original derivation of scientific knowledge by a scientist and the learning of scientific knowledge by a student. Both are acts of interpretation. When I learn a science concept, I am constructing a personal understanding of the concept based on what I perceive the textbook, or activity, or teacher to be saying. Just as a scientist interprets experience in light of a personal background of knowledge, I learn by interpretation in light of my personal background of knowledge. In contrast, rote memorization involves no interpretation, is rarely meaningful; and, therefore, most of what students memorize is soon forgotten.

The concepts of construction and meaningful learning help make sense of a widespread occurrence among people. Science education research has shown that people hold many different ideas about such things as motion, force, life, and gravity. People’s ideas frequently differ considerably from accepted scientific viewpoints even when the people are students of science. After very careful explication of a concept, students frequently come away with quite different interpretations of the concept. Even graduate level physics students have been shown to have views of the concept “impetus” that vary considerably from what is considered the scientifically orthodox view. This phenomenon prompted David Hawkins to write, “reasonably patient explanation is no cure . . . we are up against something rather deep in the relation between science and common sense; we are up against a barrier to teaching in the didactic mode which has hardly been recognized, or if recognized has been seen mainly as a challenge to ingenuity in teaching rather that as a challenge to a deeper understanding of human learning” (1978, p. 5, 7). What is the barrier? You ask, how do these scientifically unorthodox ideas happen? They happen because learning does not involve photography, but impressionistic artistry. As the learning theorist David Ausubel says, the only real learning is meaningful learning. We have learned something when it makes sense to us. The advanced physics students have a particular impression of what impetus means because that impression makes sense to them. If their impression of impetus does not resemble the teacher’s, it is because their impression is a personal construction. If learning occurred by transmission, students would either have the concept or not. What they would not have are idiosyncratic versions of the concept.

Defining Constructivism

The definition of constructivism is carried in its name. Learning is the active process of constructing or putting together a conceptual framework. The philosophical basis for constructivism is epistemological fallibilism. All knowledge is fallible by virtue of lacking exactitude and comprehensiveness. Ultimately, we can never know for sure how close our knowledge actually approximates reality. Rather, knowledge is a meaningful interpretation of our experiences of reality. If the original derivation of knowledge is by meaningful interpretation, then the learning of knowledge must also involve meaningful interpretation. Thus, no one learns by transmission. No one learns in a way analogous to the copying of a computer file from floppy disk to hard drive. We learn by making sense of what is experienced.

As I mentioned at the start, constructivism is a practical idea. Consider the following simple dialogue:

Teacher: I say to you the man is tall.
Student: I hear you say that the man is tall. I think this man is also tall.
Teacher: No, that man is only 2 meters tall.
Student: Okay, I hear you saying that the first man is tall because he is over 2.4 meters
Teacher: Yes, but you are saying the second man is tall because he is over 2 meters.

We might call this dialogue “coming to an understanding” or “clearing the air,” or “seeing eye to eye.” The dialogue demonstrates three things. It demonstrates that both the teacher and the student are learners. They learn from each other. Second, the dialogue demonstrates that learning is an interpretive process. The student had to interpret the meaning of “tall.” The teacher had to interpret the student’s response. Third, in order to help the student understand the teacher’s intention, the teacher had to come to an understanding of the student’s viewpoint,
i.e., that student interpreted tall to mean over 2 meters. This, essentially, is the constructivist model of learning. It says to us that learning is always an active process of making sense out of an experience, and that this process is much influenced by what one already knows. Therefore, in any teaching/learning situation it is crucial that the teacher come to a common understanding with the student. Constructivism says to us that learning involves negotiation and interpretation. Therefore, the teacher is advised to engage students in discourse that facilitates the actions of negotiation and interpretation. The discourse may be with the teacher or among students. In this regard, cooperative learning strategies are ideal. Constructivism also implies that activity, or hands-on learning, by itself is not enough. A good inquiry lesson will fail with many students if students are not allowed to engage in negotiation and interpretation of ideas.

There is a further issue to consider. Most people have had the experience of being in a conversation where one would swear that the other person was speaking in an unknown foreign language even though that was not the case. One simply could not make oneself understood by the other person. This failure to communicate happens when the parties bring to the conversation radically different conceptual frameworks, and this is not uncommon in the science classroom. The problem is that the student has no idea what the teacher is talking about. The issue here is contextual constructivism (worldview is a related issue; Cobern, 1994). One of the clearest examples of this in science is the topic of origins. The scientific view of origins has to do with evolutionary mechanisms that speak to the question of how. For many students, however, origins is not about how but about why. Origins is a religious topic rather than a science topic, and these students construct knowledge appropriate to the context that is meaningful to them. The result is a radical schism between teacher and student, which is made only worse when the teacher assails the student’s position without ever trying to understand the student. The solution is not to tell the students they are wrong, but for teacher and students to work through the issues together.

Conclusion

In summary, constructivism is a model intended to describe learning. The model suggests:

1. The student is always active when learning takes place.
2. This active process is the process of making sense. Learning does not occur by transmission but by interpretation.

3. Interpretation is always influenced by prior knowledge.
4. Interpretation is facilitated by instructional methods that allow for the negotiation of ideas.

Inquiry activities are powerful specifically when they promote discourse. By the same reasoning, cookbook labs and demonstrations are far less effective. Thus, if students are not talking science, you will find that many are not learning science. As to the different views of constructivism, some educators are content to use the model as a basis for developing teaching strategies. However, Glaser'sfeld (1989) is right. There are at work here key issues of epistemology and ontology. The model can be used pragmatically, but I do not think that its full potential can be realized without the support of a philosophical framework.*

Suggested Reading


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Hudson and Stiles in the June 1995 ICASE Journal have proposed nurturing the child's ecological mind as a model moving beyond the current reform that has been called Science-Technology-Society (STS). They advance their model while calling STS a "buzz word." Their attack illustrates a major problem with STS as a reform that is meant merely to result in change and improvement.

One problem is with a definition for STS. The National Science Teachers Association (NSTA) foresaw such a problem in 1988 which resulted in President LaMoine Motz appointing a Task Force to clarify the meaning of STS which even then had attracted many educators and researchers.

Two years later the NSTA Board of Directors unanimously accepted the Task Force recommendations which define STS. The NSTA definition is simple: STS is the teaching and learning of science/technology in the context of human experience (1990-1991). This surely is not the definition Hudson and Stiles used in their article.

The NSTA definition includes—perhaps emphasizes—that any reform needs to focus on learning. Interestingly the NSTA definition emphasizes technology (the human-made world) as well as natural science. But most importantly, it indicates that effective teaching and learning must occur in a context of human experiences—both past and current experiences of learners.

When Hudson and Stiles talk of a reform that goes beyond teaching and learning, beyond science and technology, a reform that ignores the context of human experience, what are the features of the reform? Their "new" model certainly incorporates the essence of STS.

STS is advanced as affecting instructional goals, teaching and assessment strategies, and the curriculum. Many STS reformers like to include curriculum last—just as many others can not conceptualize reform unless it emphasizes curriculum. Hudson and Stiles seem to fall within that trap.

But, Hudson and Stiles also focus on teacher (or curriculum) directiveness. They want environment topics to be central to the curriculum. They talk of teacher reserving time for environment activities that they (i.e., teachers) choose. They use such teacher-directed phrases as: "Children should be given," equipment "may be introduced," the model "can give students." Many have argued that "how" teachers teach is more important than what they teach (Yager & Lutz, 1994). But, Hudson and Stiles obviously feel that the "what" is more important if their model is followed.

Although Hudson and Stiles suggest many fine instructional outcomes as occurring if their model is used, their concerns for the human spirit or soul, their open desire to affect the spirit, their identification of the "correct" environmental ethic borders on religion and suggests again the danger of school science focusing on developing the "correct" view.

Many in environmental education seem more concerned with creating awareness of the environment and instilling wider use of this condition in reversing environmental degradation. This is a desirable goal—but is it science education?

Many around the world see the advantage of broadening a definition of school science. Most are willing to include technology as a full-partner—unlike the situation in the 60s where nearly everyone has concerned with the differences between the two and insisting that science be pure and characterized as a way of knowing by scientists.

In a democratic society it seems wise to posit—as Jefferson did as the U.S. democracy was born—that the citizenry must be literate and able to make decisions. Hudson and Stiles urge a model which will give students a broader view of the environment—and information about what humans are doing to further its degradation, especially in more advanced societies. But are Hudson and Stiles following their own philosophies of how humans learn and of the essence of the scientific enterprise?

References


INTEGRATED SCIENCE TEACHER EDUCATION IN NIGERIA:
HOW EFFECTIVE IS IT?
PART 2 “TRAINING TEACHERS FOR INTEGRATED SCIENCE IN
NIGERIAN SECONDARY SCHOOLS”

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Abstract

In a previous paper we identified the focus of our research and the methodologies employed(Wuyey and Turner, 1994). This paper presents a summary of the findings. The research set out to establish the characteristics, quality and appropriateness of the training of teachers for integrated science in Nigerian Secondary Schools and in particular, how that experience fitted trainees for their intended teaching appointment.

The inquiry revealed that:

• many of the students in training had poor academic backgrounds in the contributing sciences; they could be described as fundamentally deficient in the subject knowledge needed to teach an integrated science course in schools;

• for many trainees, integrated science as a curriculum device was poorly understood, particularly in relation to the philosophy underpinning it;

• there was a dearth of trained integrated science teachers in the schools to act as role models;

• there was a lack of appropriately qualified and trained teacher trainers in the training institutions.

The implications of these findings, while not a surprise to us, suggests that until these deficiencies are remedied and that both trainees and trainers are adequately versed in the curriculum implications of an integrated approach to science teaching, then the successful implementation of current science courses specified for Nigerian Junior Secondary Schools is in jeopardy. An important feature of training is to understand the integrated approach to school science and to develop an appreciation of the underlying purpose and structure of the teaching programme in schools. This appreciation, too was found to be lacking in most participants to the training enterprise and is, we suggest, contributory cause to the poor image of integrated science teaching held by many of its practitioners. The strengths and weaknesses of the current teacher education system for integrated science is discussed in terms of the emphasis in the national system of education in Nigeria on a common integrated science course for junior secondary school pupils.

Introduction

This research undertook a survey of pre-service teacher training for integrated science in some Nigerian university departments of education and their affiliated colleges. The aim of the inquiry was to establish the characteristics, quality and appropriateness of the training in preparing the prospective teachers for their job. The research sought to explore the strategies employed in training these teachers in order to gain information about the course structure, the views about the training programme of the several participants in the enterprise; and the understandings held by these participants about the aims and objectives of integrated science as a school subject.

The study sought specifically to determine the

• the characteristic features of the pre-service programme of teacher training;

• the relevance and usefulness of the teacher education programme for integrated science student teachers in relation to their future role in schools;

• the perception of “integration of science” held by practising teachers already in post, by student teachers and the teacher trainers; and to compare and contrast these views. As a result of this inquiry it was expected to be able to point to the strengths and weaknesses of the current teacher education system in this specialist field; and the extent to which the training supports the supply of good quality science.
teachers into Junior Secondary Schools. The national system of education in Nigeria requires that one common integrated science course is taught to all pupils in this age group in schools. The quality of the teachers and the adequacy of their training is central to the successful implementation of this decision.

The Sample
Two university departments of education and six of their affiliate colleges were selected for this study. One criterion for selection of an institution was that they should have been running a training course of this nature for at least five consecutive years. In this way, the experiences of course tutors can be elicited, thus avoiding those colleges which have problems that could be attributed to teething troubles. Furthermore, it was hoped that by selecting institutions in this way, the views of experienced teacher trainers could be sampled.

The sample population included the coordinators of the integrated science teacher training programmes; other teaching staff in the universities or colleges; final year student teachers and practising teachers in schools. A total of 264 respondents made up the research sample.

Instrumentation
Questionnaires were the principal instruments used for the data collection supplemented with personal interviews. Four different questionnaires were designed for the various respondents, each with a common structure. The questionnaires were designed for the:
- coordinators of the integrated science courses in universities and colleges;
- teacher trainers of the integrated science courses in universities and colleges;
- student teachers;
- practising teachers in school.

The interviews were used mainly to clarify the questionnaire responses and to probe further thereby giving confidence and reliability to the data obtained through the use of the questionnaires.

Data analysis
The questionnaires sought to obtain the respondent’s views, opinions and understanding of both of the training programmes designed to train teachers of integrated science and the nature of integrated science itself.

In some instances numerical data was sought and this was analysed using straightforward quantitative summaries and tests of significance applied. The qualitative analysis made use of a Systematic Network Analysis (Bliss et al., 1983). This type of analysis is concerned with reporting results in terms of a relatively simple category scheme. It works with defined categories, but it attempts to elaborate those categories to the point where enough of the individual essence of the data are preserved and represented.

The strategy for elaborating categories uses a notation derived from systemic linguistics that sets out category names in a manner that shows their interdependencies. The analysis generates network-like structures in which descriptive categories appear linked in a structure that shows which categories belong within others, those categories which are independent and those which are conditional on the choice of other categories. The data collected in figure 2 is constructed by using these principles.

The total of 264 questionnaires were returned, as follows:

- student teachers, final year: 144 (54%)
- practising teachers: 52 (20%)
- teacher trainers: 60 (23%)
- course co-ordinators: 8 (3%)

264 (100%)

The research sought to establish some of the practices occurring in pre-service teacher education in the field of training integrated science teachers for Nigerian schools, by revealing through the eyes of the participants the characteristics and efficacy of the training programmes.

Results and discussion
1. Characteristics of teacher training
Three characteristic features of integrated science teacher training investigated in this study included the entry requirements of candidates; the selection process used by institutions; and the content of the course as taught to the student teachers.

The findings revealed that although every institution said that, in order to qualify for admission, it required all the candidates to hold credit passes in biology, chemistry and physics of the Nigerian Certificate of Education, or its equivalent qualification, their practice was very different. Of the 144 final year students responding and receiving training in the Colleges of Education the breakdown of qualifications was: Biology 63% Agricultural science 59% Chemistry 30% Physics 9%

In other words, a typical student teacher would have an academic background in biology or agricultural science. This was the case, too, with university graduate student teachers. Most students selected for training did not have the required academic qualifications for the course of study. Less than a third had a qualification in chemistry. As in
many countries, there is a severe shortage in Nigeria of applicants to teacher training with a physics background.

None of the institutions in the sample interviewed their applicants for training places. In view of the shortage of suitable applicants for training to teach integrated science, coupled with the policy drafting into integrated science surplus applicants from other sciences training courses, it appears to us that the need to interview was redundant. Nevertheless, qualities which contribute to the skills of a successful teacher but which are not visible on an application form are not relevant, therefore as selection criteria at this stage.

In addition to academic qualifications, some trainees displayed a low interest in the course of study on which they were placed. A number of the students said that their admission and placement on a course to train as integrated science teachers was not their own choice but that of the college. This situation arises when applicants' first choice course is full and, in order to stay in college, unsuccessful applicants were directed by the Institution tutors into the integrated science teacher training course. This occurs mainly when teacher training courses are full for prospective teachers of biology, chemistry and physics.

The evidence arising from this study identifies in candidates both an academic shortfall in their background and a poor attitude to the course of study. These two negative factors are, of course, connected. In drafting applicants into courses for which they are not suited either by choice or by qualifications the institutions are, by implication, downgrading the importance and value of integrated science as a course of study for teachers. By offering places to students who are not suitably qualified to train to teach integrated science the course becomes regarded as second best. In particular, this situation suggests that teachers of integrated science are identified with those who are not regarded as suitable to train as subject specialists. This position has to change if the teaching programmes in school are to properly staffed. If Integrated Science is to establish itself as the most appropriate form of school science for the Junior Secondary School then both the subject and its teachers must be given a status equal to that of other science subjects.

The position in which teachers of integrated science find themselves is exacerbated by the fact that integrated science is not a discipline in the same sense that, for example biology is a discipline. Integrated Science is not an independent field of academic study with its associated experts and literature. It is a curriculum device used to construct a course of study for school science programmed. This lack of an underpinning discipline leads to a serious problem of status for teachers who train to teach integrated science (Black, 1986).

2. Practising teachers

Part of the study focused on the type of training these teacher received and its' appropriateness for the job. Altogether 52 practising teachers were sampled. With reference to figure one below it appears that this cohort contained teachers in one of three categories of training, as follows:

Formally trained to teach Integrated Science 23%
Received no training to teach Integrated Science 46%
Informal training* 31%

In summary then, 77% of teachers in the sample had received no formal, pre-service training in Integrated Science teaching. The nature of the

Figure 1: Training received by teachers of integrated science

![Figure 1: Training received by teachers of integrated science](image)
informal training(*) included workshops or seminars of short duration amounting to days. About 58% of the practicing teachers were male showing nearly equal distribution between the sexes.

3. The Teacher Trainers

The inquiry sampled the views of co-running the course in the colleges and universities; their numbers were small compared with overall numbers in the inquiry.

This situation is inevitable and in the nature of training process. In addition, some 51 teacher trainers were sampled for their opinions.

Within this sample of 60 staff, 10% indicated that they have had some form of training to teach integrated science. The remaining 50% were engaged by the institution because of their academic qualification in a subject (science) discipline or because of their (wider) educational background. The results of this inquiry suggests that staff of the training institutions lack Other school teaching experience or academic background in the nature and practice of integrated science teaching in schools.

Whatever their knowledge and ability as scientists or their good intentions might be the finding casts doubt upon the capacity of the staff to help students in training to teach integrated science.

All staff were asked to identify the skills and abilities which they hoped to develop in their trainees. The replies were analysed and collated using the Systemic Network Analysis. The response of the eight course coordinators is described first in figure 2.

The network summarises closely the expectations of the course coordinators and thereby the experience intended for the integrated science teachers during their course. For knowledge acquisition, the course co-ordinators specified that attempts were made to equip student teachers with sufficient broad based factual knowledge in the basic sciences and any other scientific fields relevant to the syllabus. In terms of skills to be developed by the student teachers, these were grouped into two domains, the psychomotor and the cognitive; see figure 2.

Although the list of abilities and skills represented in the Network can be said to be comprehensive and capable of imparting the necessary expertise to produce effective integrated science teachers, the ideas expressed in the summary Network are only those of the course Co-ordinators. Other staff, the teacher trainers responded less coherently to the invitation to identify the skills and abilities which they hoped to develop in their trainees.

We were forced, reluctantly, to the conclusion that the network of abilities and skills gives at best, a theoretical picture of what the course is intended to achieve. In terms of what is happening in the training classroom the picture is confused. None of the co-ordinators held views consistent with the whole network, which was not surprising; however, whereas most teacher trainers were able to identify for themselves some of the aims embedded in the network(Figure 2) few held any coherent picture. There was no holistic view of the intended outcomes of initial teacher training held in common by all staff committed to the programmes in the several institutions.

Another feature of the training programme was the expressed intention of the course coordinators to develop motivation in the students towards the course, towards the idea of integrated science and to bring about a change in attitude towards integrated science. Bearing in mind the attitudes engendered in some students by their enforced placement into integrated science teacher training course this clearly is an important feature to identify and nurture.

4. Perception and understanding of Integrated Science Education

The research attempted to obtain the participants views about their perception and understanding of integrated science as it takes place in schools. The participants included practicing teachers, student teachers and the staff running and teaching the training programmed

Participants were asked to give a definition of integrated science; these definitions were analysed and categorised. The summary of this analysis is shown in figure 3.

The most popular definition was "a subject which teaches a combination of contents from the biological and physical sciences as well as a measure of some of other related scientific fields". This response, Category 1 in Figure 3, was given by many respondents drawn from all three categories of participants; in addition, factors as qualification, training and experience of the participants did not materially alter the response. Clearly integrated science is seen mainly by most teachers associated with the programs in terms of breadth of content. This finding is further confirmation of earlier researches undertaken in Nigeria to find out how pre-service and in-service teachers of integrated science teach and understand their school curriculum (Olawaraju, 1983; Jegede, 1983; Akinmade, 1988; Madubum, 1990; Nkpa, 1991).

After a decade of teaching and research into integrated science teaching in Nigerian schools, there
is very little change in the perception by teachers of the underlying purpose of school integrated science teaching. It is of concern that, even in those teachers who claimed to have been trained, or to have benefited from some type of training in teaching integrated science, most respondents did not show any wider understanding of integrated science beyond a teaching of "combined biology, chemistry and physics."

However, participants who did have some training to teach integrated science, or who were professional school science teachers and with many years of experience did offer responses that generated category 2 (Figure 3). Such respondents reflected an appreciation of the broad range of possibilities opened up by an integrated approach to science teaching and reflected in the Nigerian Integrated Science course aims (Federal Ministry of Education, 1985).

![Diagram](Image)

**Figure 2: Characteristics of training and skill development for integrated science teaching in Nigeria**
Figure 3: Categories of integrated science definitions.

Discussion

One powerful message given to the researchers by the many course participants was that, as a school subject, integrated science was a second best subject compared with the traditional subjects of biology, chemistry and physics. Furthermore, that those teachers who taught the subject in schools and in addition, those who were being trained to teach integrated science, were second best teachers. This message was clearly relayed to us, not only in the follow up interviews with teachers responding to the questionnaires, but by staff in colleges of education and university departments of education not least by the manner in which they recruit students to their courses. It was our impression, too that the status of teachers in the field reflected a hierarchy in which integrated science teachers in secondary school were at the bottom and was reflected in the pay and limited movement of staff between the Junior Secondary Schools and High Schools. The High Schools in Nigeria recruit subject specialists to teach biology, chemistry and physics and do not generally teach integrated science.

Overall there was a strong negative attitude towards integrated science teachers. This effect must be transmitted to the pupils, making the teaching of the subject that much more difficult.

If progress is to be achieved towards a broad based science education for all Junior Secondary School pupils through the means of an integrated science curriculum, then clearly this powerful negative influence must be reversed. The courses in schools have the potential to offer a sound stepping stone and reliable base for those who go on to further study while to those whose education-finishes at the Junior Secondary School stage it gives pupils a rounded course of study in the sciences and the opportunity to understand aspects of science and technology relevant to their daily lives.

If circumstances permit, the admission procedures of the institutions offering training in integrated science teaching need to be overhauled by
developing a clear policy of entry with transparent and achievable selection procedures. If the admission of suitably qualified candidates cannot be guaranteed within this process then perhaps the policy of requiring an integrated science curriculum to be taught in schools by dedicated trained specialists might be re-examined.

The teaching of integrated science in schools need not demand one teacher teaching all the course. For example, a team of teachers might be envisaged in which the best way to deliver the curriculum is arrived at in the light of the teaching force available, e.g. single subject specialists may be deployed to teach those aspects within their compass. However it would be necessary for all teachers in such a team to understand the aims and objectives of the whole course, to ensure coherence and common purpose.

This lead us to a final point. There is an urgent need in the training of teachers to give priority to the meaning and purposes of integrated courses. If the purpose of the course and the knowledge, skills and attitudes it hopes to engender in the pupils is understood then the effectiveness of teachers is enhanced. In this way a team approach to school science teaching could be developed. This objective requires that the teacher training institutions give attention to this aspect of their programme; and that assessment of trainee teachers on a teaching practice placement has this objective in mind.

The Nigerian Integrated Science Teacher Education Project (NISTEP) has been the only enterprise directed at upgrading the teacher training institutions. At present it is based in one centre and there is clearly a need to spread the influence of this Project more widely. Such a move might be co-ordinated by the National Commission for Colleges of Education, the Science Teachers Association of Nigeria and the National University Commission.

The proper and adequate training of science teachers at both the initial and in-service stages are a fundamental requirement for the delivery of National Curriculum aspirations. Well qualified teachers are the sine-qua-non of successful curriculum implementation. Experience has shown that no matter how well an education programme has been written and developed the success finally rests on the enthusiasm, commitment and quality of the classroom teachers (Wuyep, 1986).

References

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Research on Curriculum, Teaching, and Learning

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This section focuses on the education of science teachers, and aims to communicate ideas and strategies which will assist science teacher educators to enhance and enrich their programs.

HOW CAN WE COMMUNICATE THE RESULTS OF EDUCATIONAL RESEARCH TO PRACTITIONERS?

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Introduction

This paper discusses how the teacher community can become aware of an eventually use the results and information produced by educational research. The essence of this paper was presented by request at the last ICASE meeting in Lancaster, England, in January, 1995.

For many researchers the main goal of the research enterprise has been to produce knowledge and make the findings available to the scientific community. For that purpose, introducing the outcomes and the procedures used was a matter of delivering the product to libraries, information centers and the data bases. However, for successful dissemination, the information must be put into the system and users (teachers) must become aware of it. Placement of information in the database does not guarantee dissemination.

For this reason, the use of research findings is one of the important issues of our decade and the educational field must close the gap between researchers and practitioners. The research findings must research the practitioner communities and be used for more accurate and successful implementation.

For a long time, researchers in the social sciences aligned themselves with engineers (Huberman and Ely 94). The idea was that rational research and the development process would be sufficient for the job (Research—Development—Dissemination).

Let us analyze in more detail the main issues of dissemination when the purpose of it is only spreading or exchanging information:

1. If the focus of the dissemination effort is the spread of information, the goal is to reach the large number of people using a variety of media formats, e.g. audio, video or text, usually using more than one vehicle.

2. If the exchange of information is the goal, this occurs when information, products or observations are shared. Exchange involves interactive communication through face to face visits, e-mail messages and informal conversations at professional meetings. The audience is usually small; individuals or small groups who sometimes form networks for the purpose of sharing findings about new information.

It is necessary to work on the reception side to have a message that virtually no one listens to, much less acts on. As it turned out, what is needed in the social and behavioral sciences is a more complex and less linear model for transferring knowledge from developers and researchers to users then either of the above approaches allow. Here is a definition that more accurately reflects the complexity of the process:

Dissemination is the process of communicating information to specific audiences for the purpose of extending knowledge and, in some cases, with a view to modify policies and practices.

(Huberman & Ely)

Two new ideas have been introduced in this definition, i.e. first, the receptor perspective which needs to be taken into account and second, the idea that the goal of the message is not only to deal with information (spread or exchange) but to take action.

When the action perspective is included in the purpose of dissemination, then implementation or the use of information by practitioners is the goal, and direct assistance to the user should be planned.

Innovation and Dissemination

Since innovations have become an important aim of educational practices, it is assumed that dissemination does not occur simply because information has been sent. Some authors point out
that improving school practice should include policies that clearly define and validate practices when linked with in-person assistance from experienced developers, implementors, and facilitators. In this respect, dissemination is context dependent. People in various settings often act on the basis of the traditions and values of the organization. There are general procedures or guidelines for discussion that are useful but absolute rules do not exist (Huberman and Ely, 1994).

To involve teachers in the use of research findings, several things must occur. The process cannot be seen as a technical process. There are no reasons why teachers must act and work as if they were part of the research community when they are not. The boundaries between professional practices are in a constant process of redefinition and there is increasing pressure on different professional groups to collaborate in the provision of services (Elliott, 1980). For practitioners to use research findings a new conception of professionalism including permanent learning must be developed (Saez, 1987).

If change is interpreted as an evolutionary progression in society, it can be steered by the state (Handy, 1989). Human needs under this type of change remain fairly constant as do the forms of their provision. The "infallible expert" image matches a society conceived as a stable and unchanging state.

In the "infalible expert" model of professionalism, the acquisition of knowledge and the development of competence are two rather different processes. Propositional knowledge (knowing that) can be acquired off the job, while competence may only be developed through direct experience. According to this point of view, competence is the ability to apply knowledge in ways which generate correct practical responses to a situation. This ability is acquired by learning through experience to recognize applications of knowledge drawing on common sense stereotypes that have evolved as part of the professional culture and which are mediated by its guardians. "Knowing that" is the foundation on which competent "know how" is built, because one does not test knowledge directly in assessing competence, but in terms of pre-specified performance outcomes and inferring adequate knowledge from such evidence. Direct testing for "knowing that" and assessing competence or "know how" are quite different activities.

**Reflective Practitioner Model**

Other authors (Schön, 1982, Elliott, 1980, Ebbutt, 1986) proposed another model of professionalism years ago, the "reflective practitioner," grounded in a different understanding of the nature of social change than mentioned above. If change is seen as discontinuous and unpredictable, human and social problems have unstable definitions and explanations; understanding becomes situated, personal, controversial and negotiable through dialogue with others. The role of the practitioner, rather than operating as an infallible source of relevant knowledge, should be to participate in a process of collaborative problem-solving through which the relevance and usefulness of his/her specialist knowledge can be determined and new knowledge acquired. Knowledge acquisition becomes an integral dimension of situational problem-solving. The practice itself is a form of learning which some used to call action/research (Elliott, 1980). Professional learning in this context is a dimension of practice, rather than a segregated activity.

From the perspective of the "reflective practitioner" model, professional competence is different from the "infallible expert" and consists of the ability to act intelligently in novel and unique situations that require what constitutes an appropriate response to be learned in situ. Competence cannot be defined simply in terms of an ability to apply pre-ordained categories of specialist knowledge to produce correct behavioral responses.

Within this model of professionalism, stereotypical applications of knowledge are to be avoided because any attempt to pre-specify correct responses or performance indicators constrains intelligent practice (Martineck, 1988; Shavelson, 1986). Instead they need to focus on the qualities of judgment and decision-making which are indicative of capacity for understanding situations holistically, for looking at it from a variety of perspectives allowing wise and intelligent responses in novel and unpredictable situations.

For the "reflective practitioner," the acquisition of relevant and useful knowledge cannot be separated from the development of competent intelligent action in unpredictable and complex social situations. The viewpoint must be its relevance and usefulness, determined by one's own competence in reflecting about such situations and how to act wisely on them.

The professional knowledge of the reflective practitioner, as (Schön, 1982) has pointed out, consists of reflective situational understanding, stored in the long-term memory. When confronted with a new situation, the practitioner selects cases from experience and contrasts them. This eclectic use of past experience illuminates aspects which may be significant for clarifying the new situation and determining the appropriate response; constructing new meaning.
Of course, the professional knowledge of the "infallible expert" is contextualized by being associated in the memory with stereotypical cases of its application. But the infallible expert does not use these cases as a basis for reflective comparison. Rather they are not used reflectively as a basis for intuitively subsuming the new situation under pre-existing categories of knowledge.

Elliott (1980) argued that intelligent practice, e.g., knowing how to perform educational activities like teaching, curriculum development and evaluation, cannot directly spring from knowledge of theoretical principles about practice, since these principles themselves derive from the analysis of practice. The principles are abstractions from practical knowledge embodied in concrete performances. One does not first understand a theoretical principle about education and then apply it to an analysis of practice. Understanding emerges from the analysis. Thirdly, theories about concrete practice rather than generalizable features, are bound to a particular substantive context.

**Collaboration for Dissemination**

For all these reasons dissemination of research can no longer be produced for a group of people (researchers) completely separate from the practitioners. From this point forward, it must be regarded as a collaborative work (Saez, 1991), where the focus and goals of research are decided on as a negotiation among the different concerns.

According to the methodological point of view, the requirements for collaboration include:

1. To use qualitative methods which can overcome the reductionism of positivist sciences and their paradigms (Hopmann & Riquart, 1995), because it is recognized that educational research does not hold to causal effect but to a more complex network of elements that are often impossible to isolate as single variables. The holistic perspective of the situations should be emphasized and the research must be described within the context where it takes place.

2. That the focus of the research will be on problems and issues emerging from practice and therefore must be defined and formulated by the collaboration between practitioners and researchers.

3. The need for a conversation of practice among researchers, practitioners and policy-makers that extends the knowledge about educational processes, institutions and phenomena. We need to understand issues of implementation to overcome the existent gap among policy, theory and practice. For discussion purposes, implementation will be situated within a cycle of inquiry. The cycle of inquiry, referred to as a holistic process, begins with establishing an inquiry purpose. The view of inquiry (Guba, 1994) is based on cycles of activities where people are engaged in a variety of actions to achieve particular purposes. Practitioners, researchers and policy-makers are all seen as inquirers who are engaged in activities driven by particular purposes.

To establish a common base for exploring implementation within a cycle of inquiry (Guba, 1990), it is necessary to consider the term in a decontextualized form, and returning to the context of use to construct a situational definition and alternative ways of knowing. These definitions form an important base for conversation of practice. Working in such a way, all members of the educational enterprise are seen as potential inquirers. Inquiry is viewed as a conceptually based process that depends on the person, the purpose of the study, the way people view the phenomena, the background knowledge of the inquirers, and the way in which they conceptualize and implement the inquiry process. Underlying this perspective is knowledge generation of a constructivist nature. Knowledge is interpreted and then integrated into the audience’s perceiving, believing, acting and evaluating everyday life in the context of practice.

**Doing Research**

When doing case studies, describing educational events within their context becomes extremely important. The description should be so realistic that, for the readers, the school is recognizable. The reader should be able to note the aspects that are particular to the setting and those that seem similar to the broader array of educational phenomena. The data in this descriptive narration must focus on groups or their activities, e.g. teachers, pupils, teaching and learning strategies, and the changes. The narration is a story of the events, based on the common sense explanations of the participants who reflect the reasons of the events as they occurred. The level of abstraction resembles that of investigative reporting. The study contributes to knowledge by preserving a record of a past event compiled by an expert observer.

The initial case study description is followed by analysis and interpretation. The researchers analyze selective aspects of human actions and events in order to construct explanations. The complexity and the interrelationships of the events and in human lives is emphasized. The study contributes to knowledge by
providing an understanding of the phenomena studied. This type of case study potentially enables others to recognize and anticipate what may occur in similar situations. These studies focus on how schools differ in terms of the innovation and the limits within the school’s context.

Research problems originate in the field, but theoretical literature is essential for recognizing and exploring the problems more closely. The researchers begin with preconceived problems that may change to fit the reality of events. The data base is extensive, including direct on-site observation, having a holistic emphasis on multiple data sources and skills in noninterfering observation, listening and recording, as well as the selection of a research role. The description of the context includes field notes as data and is written at a level of abstraction appropriate for the purpose of the study. It is a record of a natural even which provides an understanding of the complexities of an educational phenomenon.

The case study researchers must emphasize the holistic view of the setting. The researcher provides a sense of totality by representing the social, temporal and overall relationship in the field. It is clear that it is impossible to observe everything, but sufficient data can be obtained for a holistic emphasis by using multiple data sources. The essence of this lies in obtaining different types of data from different persons in different organizational positions in different situations at different times. Multiple data sources can best be illustrated by listing the methods, participants, situations and organizations in the study to show the different perspectives and views. In constructing explanations, the group of researchers looks for convergence of their data sources and develops sequential, phase-like explanations, assuming that none of the events has a single cause.

**Summary**

The educational practitioner must be regarded as an equal partner in the research enterprise, otherwise our efforts in improving educational practice will be in vain.

**References**


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**Australian Model Solar Car Challenge**

**November 1996**

In November 1996 students from across Australia will meet in Adelaide to compete in the Australian Model Solar Car Challenge, the culmination of state-based challenges conducted from September to November in New South Wales, Victoria, Queensland, South Australia, Western Australia, Tasmania, and the ACT.

**Location**: Adelaide, Australia

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When to Use Overhead Transparencies
Chemistry teachers can use various teaching methods to increase student cognitive activity: demonstration and laboratory experiments, group work, role plays, or work on local and international projects, just to name a few. Another way to animate chemistry classes is to use overhead transparencies, especially for complicated theoretical concepts, e.g., atomic mass and chemical bonding. Overhead transparencies can provide students with visual models for these abstract concepts. Pedagogical process research (P. Leppik, 1993) has shown that a teacher who uses only verbal teaching methods works resultively with less than half the class.

Overhead Transparencies Students Prefer
Students are not fond of “dry” descriptions of facts or phenomena. They prefer overhead transparencies that set problems and problem situations, give puzzles, or represent the surrounding world in a humorous way. The author’s experiences confirm that vivid and fascinating problem presentations mentally excite pupils. All this promotes knowledge acquisition and greater concept understanding.

Some Examples
We have composed 20 overhead transparencies in above mentioned style. They reflect the diversity of the surrounding world (atoms, molecules, crystals, substances, solutions) or are used to develop students’ skills, including safety. These overhead transparencies were designed to be used in our first chemistry classes (in grade 8 in Estonian schools) or in an integrated science course. This article shows several examples of how transparencies can help students make connections and enhance mental operations.

For example, students analyze the situation shown in Figure 1, draw conclusions, count the mistakes, and discuss proper laboratory techniques.

Figure 2 deals with an extremely complex but important chemical concept: “How are atoms weighed?” The concept “atomic mass” can be made more understandable if we use analogy and a comparison with daily life situation. For example, “an atom is like an orange divided into 12 equal pieces.” Students conclude that atoms are “weighed” by comparing their masses with atom mass similar to buying sugar in a shop.

In Figure 3 students must identify the attribute or idea that ties these pairs of objects together, i.e., that they are connected by their masses. In other words, ratio of a proton’s and electron’s masses is the same as the ratio of a fox’s and a mouse’s masses.

Chemical bonding is explained by using a “chemical fairy tale.” Here the formation of the ionic compound sodium chloride (NaCl) from sodium and chlorine is presented. First we model the periodic table of elements as a big house for 111 inhabitants (Figure 4). Our fairy tale begins with the words: “Once there lived...” let’s say: among 111 inhabitants there lived a young man Sodium and a girl Chlorine. There was a strong attraction between them. One day Sodium begged Chlorine to go for a walk (Figure 5). However, Chlorine was not warmly dressed and felt cold so Sodium gave her his coat. “What did Sodium give away?” (= a valence electron).

Conclusion
Having students analyze problems, make decisions, draw conclusions, and use models allows a teacher to stimulate cognitive activity and expand understanding. Based on the author’s experience, comparing and connecting invisible objects and phenomena of the microworld with those of the macroworld leads to better understanding of these complex concepts.
References

Against which safety demands are the pupils mistaken?

![Figure 1](image)

How are atoms "weighted"?

![Figure 2](image)

What holds particles together in compounds?

![Figure 4](image)

In which connection can a fox, a mouse, a proton and an electron be?

![Figure 3](image)

![Figure 5](image)
A LONG SOAK FOLLOWED BY REPORTS OF INTENSIVE SWIMMING:  
A TALE OF INSERVICE COOPERATION BETWEEN 
THE PHILIPPINES AND AUSTRALIA

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Introduction

The Secondary Education Development Program in the Republic of the Philippines, begun in 1988, has involved major curriculum change and consequent whole-country inservice teacher education for all components of the secondary (Grades 7-10) curriculum. Within this context the Philippines-Australia Science and Mathematics Project (PASMEP) has contributed to chemistry, physics and mathematics in Grades 9 and 10 (the last two years of Filipino schooling) through equipment provision, “Training the Trainers” programs for those who were to conduct the inservice teacher education programs (INSET). In this article we consider one of the two Monash involvements in PASMEP. This was focused on the Grade 10 subject “Science and Technology”, referred to here as S&T4. This is a physics subject. Our brief was to provide a special purpose, 10 month, full-time program in Australia in 1990 for 34 selected trainers, and to work in four follow-up workshops in the Philippines in 1991 and 1992 for these and 28 further trainers. These experiences addressed physics content, teaching and learning strategies, nature of INSET, designing INSET, etc. Below we give some background to the Philippine context and to this Monash component of PASMEP. We then consider the features of the Monash program, discuss the consequences of the program, and address some general issues arising from the work. Before this we very briefly consider some past approaches to teacher development for major curriculum change in order to give relevant context for the significant processes and outcomes of the PASMEP S&T4 program.

An Outline of Some Past Practices in Inset for Major Curriculum Change

When a country embarks on a major reform of its school science curricula it is also faced with the very substantial issue of professional development. This INSET of those who are to teach the new curricula, and who have been with varying degrees of success and experience teaching previous curricula, is probably the most critical factor for successful implementation (e.g., Zoller & Watson, 1974; Fullan, 1982).

However affluent the country or however poor, however developed or however developing, the problems of persuading, informing, and equipping the existing teachers to change in the ways required by the new curricula are similar. Changes required by new curricula can include new content emphases, new laboratory intentions, new forms of assessment, new pedagogics and new teaching roles. Often these are required of teachers who have been accustomed to and, in many cases, successful in teaching science in other ways.

In general, it is true that the richer countries have more resources for tackling these problems than do
the poorer countries. However, richer countries can have considerable difficulty in bringing these resources to bear on the problems in an effective and coordinated manner. Because education for development is an international aid and loan priority, it does sometimes occur that a less developed country with the capacity to plan and organize also has access to the substantial resources needed to implement its plans. Quite remarkable results can then emerge.

Thailand in the 1970s is an example of this phenomenon (Fensham, 1986). Given the ways the above problems and their solutions were conceptualized at that time, and using the dual criteria of extent of coverage of the teaching force and the thoroughness of the induction into the intended curriculum changes, then Thailand achieved professional development of its science and mathematics teaching force which was at that time without parallel. Wongthonglour (1979) has documented and evaluated this professional development in the specific case of a new Physical Science curriculum.

In this present paper we describe a similarly remarkable success story from the 1990s, in which professional development occurred in the Philippines on a scale and of quality that far exceeds anything that has been yet possible in the cooperating donor country, Australia. The nature of the approaches contributing to this success reflect current conceptualizations of the problems of professional development and curriculum implementation, and current ideas of how to tackle the problems. These differ from the conceptualizations and approaches of the 1960s and 1970s, differences that result from research in the intervening years. In brief, the differences of importance in the S&T4 program involved our greater understanding and the participants’ eventual acceptance of: learning and conceptual change, including the need for time; the recognition of the importance of role models and sustained support; seeing incremental degrees of change; embracing conceptual change in content and pedagogy; accepting the need for networks to support change; and accepting that the translation of ideas into the local context has to be the responsibility of those who work in that context. We elaborate and justify these after giving an outline of the relevant contexts of participants and of the structure of the S&T4 PASMEP program.

The Philippines Context and PASMEP

Formal education in the Philippines, an archipelago of 7000 islands with a population of over 60 million, is modeled on the U.S. system. Six years of free compulsory elementary (primary) education are followed by four years of secondary schooling. A policy of free public secondary education was included in the 1986 constitution, and the consequent abolition of tuition fees at this level began in 1988. The Philippines takes pride in being one of the Asian countries with high rates of adult literacy (about 86 per cent in 1988). It has relatively high participation rates at all levels of education (over 45% of each age cohort was completing secondary schooling in the late 1980s, and of the 17-24 age group, about 16% were enrolled in post-secondary education). The organization of and policy for school education derives centrally from the national government and is supported by 14 administrative regions, each of which has a Regional Science and Mathematics Teaching Centre attached to a Teachers College or University. There are, in total about 3.4 million secondary students. The private sector is strong—about 40% of secondary and 80% of tertiary students are in private institutions.

The secondary science curriculum reflects the US influence already noted. The Grade 7 curriculum ("Science and Technology 1") is general science, Grade 8 ("S&T2") focuses on biology, Grade 9 ("S&T3") on chemistry and Grade 10 ("S&T4") on physics. Officially, the language of high school science instruction is English (Filipino is used for some other subjects). In practice, local dialects are sometimes used by science teachers in rural areas and areas remote from Manila. English language proficiency varies across science teachers.

The contexts for science teaching are variable. Public schools, on which PASMEP focussed, are either nationally funded ("National High Schools") or locally funded with partial national funding for teacher salaries ("Barangay, i.e., village High Schools"). Although only 22% of the 3,400 of public high schools are national, these employ two-thirds of high school teachers and enroll about the same proportion of students. Locally funded schools thus are very often small, and often very poorly resourced. National high schools can be very large (enrollments of several thousand). A few National High Schools are designated Science High Schools. These are generally well resourced and staffed—S&T4 classes of under 30 occur here. In other National High Schools, S&T4 classes of 45+ are the norm and equipment is often lacking. There is also a substantial shortage of physics teachers with less than 10 per cent of S&T4 teachers being physics majors. The total number of S&T4 teachers in the country is between 6,000 and 7,000, many of whom have backgrounds in biology, mathematics, social sciences on language.
Each region has a designated Regional Leader School in science. This school has frequently served as the location for whole region INSET, and was the site in each region for the S&T4 whole country INSET with which we were concerned.

The PASMEEP project came from negotiations between Philippine government agencies and a small group of Australian experts (including one of us) late in 1986. It involved provision of equipment for Grades 9 and 10 to about 380 schools (largely focused in three regions), a program for teacher educators, trainer programs for INSET of Grade 9 and 10 mathematics teachers and Grade 9 S&T3 (Chemistry) teachers, and a supplementary materials development project for Barangay school teachers. The two programs for Grade 9 ran a year ahead of the programs for S&T4 and Grade 10 mathematics.

From 1989 to the end of 1992, Australian co-ordinating staff in the Philippines worked closely with the local PASMEEP staff and the Philippine government agencies charged with overseeing the implementation of new educational programs.

The S&T4 PASMEEP Program

The stated basic purpose of the S&T4 PASMEEP program was to develop the participants ("fellows") to be trainers who would carry out in 1992 the INSET of all government high school physics teacher for the new S&T4 curriculum ("mass training"). The fellows who came to Monash were selected by the Philippine authorities who used a variety of tests (including one of physics knowledge). They were current S&T4 high school physics teachers, not physics academics or physics teacher educators—an unusual choice, given the traditions of science INSET in the Philippines and the inversion it represented of where the expertise in INSET was seen to lie. It was, however, a choice of great significance, particularly in relation to the importance of role models.

In 1989 one of us visited the Philippines to see schools, to talk with teachers, and to negotiate the broad structure of the 1990 program with staff from the Bureau of Secondary Education (the relevant National Government agency), ISMED (The Institute for Science and Mathematics Education Development at University of the Philippines, a body that for many years has led innovative curriculum development and INSET activities), and those involved with implementation of PASMEEP and the new curricula.

There was clear agreement that the major influence of the fellows in their eventual roles as change agents would, in reality, be in contexts other than mass training: in their own schools, in ongoing local INSET, etc. This did not diminish the importance of the mass training role, but placed that role in a broader and longer term INSET context. This issue was of major importance to our approach.

Thirty four trainers spent February to November 1990 at Monash: 2 teachers from each of the 14 regions in the Philippines; a third teacher from each of the three regions on which PASMEEP had a particularly strong focus; one physics educator from Bureau of Secondary Education; and 2 physics educators from ISMED. Subsequent follow up workshops in the Philippines were held in January 1991 (1 week), May 1991 (4 weeks), October 1991 (2 weeks), and January 1992 (2 weeks). In the May 1991 and later workshops a further two physics teachers from each region joined the group to become trainers, and in the last two workshops, teacher educators (who had undertaken another year-long PASMEEP program) and some selected school administrators were present for part of the workshop. All these personnel made contributions to the 12 day mass training programs, in April or May 1992. An intended presence of Monash staff as observers at mass training was canceled because of its concurrence with national elections. A subset of the fellows was also involved in 1991-2 in a series of curriculum writing and equipment use workshops organized by the PASMEEP staff in the Philippines. We were not involved in these. A number of local and regional INSET programs were, as intended, conducted by the fellows through 1991-2 (and, of course, subsequently).

In outline, the 1990 program focused on physics content, on issues of curriculum, learning and teaching, and on the nature and provision of INSET. The culmination of the program was the production of resource material for use in INSET or classroom teaching, and explorations of varieties of these resources. (Other components of the 1990 program, such as the Australian context and learning word processing, are not considered here.) The follow-up workshops in 1991-2 were a mix of additional materials production, further planning for mass training, training the new fellows, and trial of approaches and considerations of other INSET (both what the teachers had attempted on return to the Philippines and what they might attempt).

The Rationale For the S&T4 Program

In an earlier section we listed some features of the approach to our work with the S&T4 trainers (understanding of learning and change, time, role models, networks and sustained support, accepting responsibility for adapting ideas). Here we describe these more fully, indicate our justifications and give some sense of how the features played out in the program. One obvious difficulty in this need to
discuss the features somewhat separately is that in the real situation they were interrelated in a complex whole. A further difficulty is the presence of another complex interaction, that of teacher, learner and subject matter, or, in the terms of Hawkins (1973), the interactions in a three term communications relation-teacher, learner and subject matter. The importance of this second complexity is embedded in some of the features of the program.

At the heart of the program was a constructivist view of learning (e.g., White, 1988) and a recognition that what was known about conceptual change in school students had appropriate parallels in conceptual change in teachers (Gunstone and Northfield, 1986). Of particular importance in these parallels is the scheme advanced by Posner, Strike, Hewson and Gertzog (1982) for considering conceptual change: there must first be dissatisfaction with the existing conception, and the new conception must be intelligible, plausible and fruitful. Concern with the fruitfulness of new conceptions was a pervasive theme throughout the program. Collaborative work with teachers, for example, the Project for Enhancing Effective Learning (Baird and Mitchell, 1986; Baird and Northfield, 1992), has shown clearly the fundamental importance of time and of collaborative, sustained support (a “network” of support) in fostering teacher change in conceptions of learning and of appropriate pedagogies. We thus had no illusions that we could expect too much early in the 10 month program and considerable personal support, including much peer support, was built into our approaches. PEEL and other projects have also pointed to the importance of role models. These are significant not only for the obvious reason of providing an exemplar to learn from but also for the more profound reason of the “learner” seeing that the “teacher” values ideas sufficiently to use them him/herself. In other words, part of the value of role models is intertwined with the fundamental importance of teachers of teachers practicing what they preach (Gunstone, et al., 1993). One other theme running through the above, and described in detail in a number of the associated references, is metacognition. In the context of the S&T4 program, it was necessary for the fellows to become aware of, to understand and, in due course to accept the approaches we used, particularly in terms of the contributions these approaches could make to their own learning. Time once again is a major issue for such metacognition, indeed even just for arriving at a state of dissatisfaction with current conceptions of teaching and learning.

The above outline is relevant to the approaches we made to both physics and to learning and teaching. The large bulk (75%) of the first half of the 1990 program was devoted to physics content, and most of that to fostering a genuine understanding of fundamental concepts through the consistent use of a range of teaching approaches congruent with the conceptual changes this goal required (e.g., concept maps, predict observe-explain, interpretive discussion; see White and Gunstone, 1992).

In the physics content component the Monash staff (who included Australian school Physics teachers) were role models for the fellows as subsequent users of the same strategies for the same learning goals with their students. Through this time the fellows were encouraged to keep diaries about their learning which were used, inter alia, for later considerations of learning and change. Sessions were gradually introduced for the consideration of teaching and learning via these physics learning experiences. Dual agenda (i.e., in this case, learn physics and at the same time consider learning and teaching) were a common feature of the program. For example, as part of our focus on INSET later in the year, the fellows had two separate experiences of INSET workshops of relevance to the program (one focused on an Australian curriculum development, the other on the physics PLON project from the Netherlands). As well as being of value as experiences, these two INSETS were also analyzed by the fellows as examples.

In the second half of the 1990 the program was increasingly concerned with learning, teaching, INSET and professional development (85%) and physics learning focused on more specialized aspects—frontiers of physics, STS, nature of science. As fellows’ understanding of professional development grew they related this to a 4 x 3 matrix which had on one axis your classroom”, “your school”, “local schools”, “regional/national” and on the other “physics”, “learning and teaching”, “change”. Each cell of the matrix contained questions and issues of relevance.

In the latter part of 1990 modular materials were generated by groups of 5 or 6 fellows. Each had a structure for up to one hour of INSET, and each was required to focus on one physics concept from the new S&T4 curriculum and one teaching strategy. The concepts were determined by a simplistic form of Delphi technique as likely to be the more difficult ones for the teachers who would be undertaking the mass training. The teaching strategies were selected from the experiences in the program. A total of 103 modules (which we called “components”) were produced, and 53 different teaching strategies were used. In the last few weeks of the Monash program we focused on seeing the set of modules as a resource.
to be selected from. We used a building metaphor to emphasize the need to include a linkage between selected modules ("cementing") that would be different for each new purpose. A wide variety of purposes was explored by taking cells from the 4 x 3 matrix (e.g., use the modules to generate a teaching sequence for your S&T4 class, generate a 1/2 day INSET about different teaching strategies for local physics teachers). "Selecting and cementing for mass training was largely left for the 1991-2 follow up workshops.

The same broad approaches were used in the follow-up workshops in the Philippines. Clearly time was much shorter with the 28 new fellows who joined in May 1992. However the power of role models was evident here. In the 1990 program, acceptance and then valuing of our purposes and approaches by the first group of fellows was a long and demanding process. For some it took months. In May 1991, some of the new trainers had embraced much of our approach before the end of week 1. They informed us that this was due to the presence of the group who had been at Monash, and the ease with which the new fellows could check with these peers the likely value of what Monash staff were doing and asking them to do.

**Some Outcomes**

Here we give account of common outcomes among the fellows, both in terms of the 1990 program per se and in terms of subsequent actions in the Philippines. The outcomes were not, of course, common across all fellows.

Evidence of change during 1990 was strong: change in physics conceptions, in conceptions of pedagogy, and in awareness of the conditions appropriate for fostering change. While much "conventional" data (e.g., test performance) supports this assertion of considerable change, more powerful evidence is found in fellows' diaries and other manifestations of their changing perceptions. The planned absence of a detailed yearlong program when the fellows arrived is a good example of this. This absence was very distressing to them all. Some months later most had changed to the point where they could argue why such a year-long timetable would have been inappropriate, and indeed often made suggestions to change the plans for the current few weeks. Most also accepted and could articulate the position that experiencing the flexibility of our program was a necessary part of understanding the absence of a detailed timetable. Our choice of physics content for our starting point—teaching of mechanics and heat—was also an initial problem. We began with this content as about 50% of the weekly program for two related reasons: while it was seen as familiar content by the fellows, as both areas were central to both the existing Grade 10 physics curriculum and to S&T4, we were aware both from the extensive research literature and from the physics tests done by the fellows during the selection of participants that their understanding of these content areas was not always deep; and we intended to teach this partially understood content via the new pedagogies we were anxious to have the fellows experience. The early focus on these content areas however caused considerable unrest among the fellows who expected to be learning those topics which were new in S&T4, and hence unfamiliar to them. We had also planned early sessions (about 25% of the program) on the general Science, Technology, Society (STS) curriculum movement to which the new S&T1-4 programs were a Filipino response. At this early stage of the Monash program this strand had no resonance with the fellows' conceptions of and expectations about the Monash program. We hastily deferred considerations of STS until later in the year and began to consider physics topics which were new to S&T4—radioactivity then nuclear energy. In this way we did attempt to be responsive to where the fellows were in their thinking about the program and in their initial ideas and beliefs of what it was going to mean to be a trainer of other teachers.

In terms of the fundamental purposes of the project our data about fellows' activities on their return to the Philippines, and subsequently the activities of the group who joined in May 1991, are more important. At the first follow up in January 1991 we asked the 31 high school teacher members of the group to describe anything they had attempted to do since returning from Monash two months before. All but one gave convincing accounts of the trials and successes of their use of alternative teaching strategies in their own S&T4 classrooms. A significant number had already run informal INSET sessions for local physics teachers. One had initiated lunch time seminars on alternative teaching strategies for pre-service students on teaching practice in his school with the student teachers being from all school subject areas. This activity in areas other than mass training continued to grow throughout 1991-2, with the whole gamut of likely practices being evident (from individual classroom work to ongoing INSET).

As already noted we were unable to be present at the mass training. However PASMEP staff based in the Philippines were, and we have their reports, feedback from the trainers, and an occasional evaluation from a teacher being trained. These data point to a consistent feature which separated this mass training from the more usual approach to
INSET in the Philippines. The trainers had indeed accepted the need for them to be pedagogical role models for their trainees, and the fundamental importance of this to the trainees at least considering adopting the new teaching strategies included in mass training for their own classrooms.

The whole program can be characterized, in an aquatic metaphor, as a long soak followed by repeats of intensive swims. Between the swims (the follow up workshops) there were other significant events and aspects with which Monash was not directly involved. These aspects provided temporary but very important opportunities for the fellows and the Philippines-based staff to experience ownership of and responsibility for the future of a physics curriculum that was always theirs and never some Australian imposition. Each of these aspects also contributed to the support and network issues we have addressed above. They included curriculum and equipment workshops conducted by PASMEP staff in the Philippines, fellows collaborating in the provision of regional and local INSET programs, and, most importantly, the strong support for PASMEP and the trainers given by staff at ISMED and by the Director of the Bureau of Secondary Education. The active support of these significant local educational agents has encouraged trainers to pursue their INSET work beyond mass training, and has led also to the formation of a PASMEP alumni. This body provides a structure for maintaining the network in the absence of PASMEP which has now formally concluded. We have, indeed, learnt a great deal about how co-operative action, in which the initiatives shift from one partner to the other until the intended consequences of the action are established and ongoing, can be mutually rewarding.

ACKNOWLEDGEMENTS: Many outstanding professionals contributed to the success of the PASMEP S&T4 program. We particularly acknowledge Mrs. Mary Brown, Ms. Helen For gasz, Mr. John Gipps, Ms. Christina Hart, Dr. Ian Mitchell, Ms. Joan Szalman (Monash University): Mr. Geoff Sanderson, Mr. Garry White and other PASMEP staff; Ms. Nenita Crisologo and staff of EDPI-TAF, Department of Education, Culture and Sports, Republic of the Philippines; Ms. Jo Pabilio and the other physics staff of ISMED; Dr. Avelina Ilagas, Director of the Bureau of Secondary Educations, Department of Education, Culture and Sports, Republic of the Philippines, who not only provided all the bureaucratic support which only her of fice could give but did so in a most insightful and inspiring manner.

References


Assessment and Evaluation Trends

This section focuses on new trends in student, teacher, and program assessment and evaluation and aims to communicate the latest educational reform efforts.

Section Editor
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South Africa

WAS I SUPPOSED TO KNOW THAT?
TEACHER UNDERSTANDING OF SCIENCE SAFETY ISSUES

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Editor Note: Science safety concerns are not unique to one country. The goal of this paper is to describe the findings from the United States so other organizations and countries consider examining their own situation. The author may be contacted directly for copies of the survey instrument.

Methodology

The author became very concerned about how this lack of safety knowledge might translate into safe teaching and learning in our nation’s school science environments. He decided to try more formal assessment techniques to verify suspicions. In early 1994 written survey questionnaires were prepared addressing three major aspects of science safety:

- Safety Management
- Chemical Management
- Legal Aspects

It was anticipated that these questionnaires would be administered at the beginning of all safety training programs conducted by the author over a year’s time. Table 1 outlines the specific items addressed within the three major safety components. In many instances, the participants could not relate to the items at all. In extreme cases, they were totally unaware of even the need to know.

In a one-year period, 300 science educators were surveyed at the beginning of each workshop conducted in the states of California, Illinois, Louisiana, Mississippi, New Jersey, Oklahoma, Pennsylvania, Tennessee, Texas, and Utah. These workshops included NSTA conventions, State Department of Education hosted seminars, and local district training programs. All participants were volunteers.

Background

During the past 10 years there has been a great deal of federal, state, and professional or organizational activity surrounding safety in science settings. Thousands of orientation and training programs for professional science educators (supervisors, teachers, preservice professionals) were offered. This author has conducted safety programs at national and regional meetings of the National Science Teachers Association (NSTA) as well as state and local settings for the past 15 years. In the last year, however, he became concerned about the effectiveness of such efforts and decided to attempt to assess participant understanding of safety issues. At first the inquiries were limited to informal inquiries of the participants, however, when it became clear that there was a problem with teacher understanding of vital issues, he decided to probe into the issue in a more formal manner.
Table 1

Science Safety Survey Items

Legal Issues
Tort law
Sovereign immunity
Save harmless provision
Negligence
Due care teaching duties

Safety Management Issues
Equipment
Ground fault interrupters
Fire extinguishers
Eye protective equipment

Facilities
Entrances & exits
Exhaust hoods
Drench showers

Procedures
Placement of safety equipment items
Class size limitations

Chemical Management Issues
Storage
Right-to-Know legislation
Chemical Hygiene Plan legislation
NFPA Hazard rating system
MSDS

Safety Management Issues

This component of the assessment focused on performing safety assessments of teaching techniques, equipment used in teaching, and the teaching environments used.

Only 16% (48 of 300) of participants assessed knew the function of ground fault interrupters (GFI’s). This strategic piece of safety equipment helps prevent electrocution due primarily to faulty grounds in electrical wiring. They are typically placed on electrical outlets in close proximity to faucets, where the reliability of electrical grounds is uncertain—as in older buildings, or where other potential electrical problems exist.

Fourteen percent (41 of 300) of participants knew the best type of fire extinguisher to place in science labs. For most general labs, ABC tri-class dry chemical extinguishers are generally recommended, unless there are other unusual circumstances which exist. Where computers, or other sensitive electronic equipment items are a regular part of the lab, halon extinguishers are generally recommended. The author, a commercial airplane pilot, knows that halon has been used in the aviation community for more than a decade because of its effectiveness in extinguishing all three classes of combustible materials (paper, grease/alcohol, electrical). Halon also provides “reasonable” pilot health protection when used in the confines of a closed cockpit.

Only 4% (12 of 300) of participants knew the American National Standards Institute (ANSI) symbol for compliance with breakage and burn standards for eye protective equipment items such as goggles. ANSI, an independent testing agency, tests many types of safety equipment and then certifies them for government regulations. The Z87 symbol, reflecting compliance with this ANSI clause, is generally placed on the faceplate and/or molding of the goggle along with the manufacturer’s trademark. Compliance with this standard guarantees that the goggles will not burn under normal conditions. In addition, they will not break, shatter, splinter, or fall backwards into the user’s face, when subject to the impact of a 1” ball bearing dropped from 50” or when impacted by a quantity of 1/4” ball bearings traveling at 150 feet per second.

Nineteen percent (58 of 300) of participants knew that, unless other circumstances dictate, chemical exhaust hoods should be placed as far away from primary lab entrances/exits as possible. Air would be drawn from the primary entrance across the room and exhausted through the hood. This placement also prevents explosions, or other complications in the hood, from blocking the primary exit to the lab.

Seventy-one percent (212 of 300) of participants knew that science labs should have at least two entrances/exits and that these should accommodate various human handicaps (wheel chair, crutches, etc.). Doors to these entrances/exits should also open outward in order to facilitate rapid egress during emergencies. Such portals should also be kept clear of clutter. All laboratories should be designed with efficient, safe egress as a priority. Subpart E of 29 Occupational Safety and Health Association (OSHA) 1910, contains specific minimum requirements for exits and egress in case of general emergencies and fires. The 1988 Uniform Building Code requires educational laboratories using hazardous chemicals to have two exits from any room larger than 500 square feet. The doors from a high hazard area, such as a lab, should swing out in the direction of travel (outward opening doors). They should be clearly marked to assure safe egress in the event of an emergency in which one doorway becomes impassable.

Twenty-one percent (63 of 300) of participants knew that, in the event of a chemical splash to the eye, that medical experts recommend flushing with temperate, aerated water for 15 minutes. This time frame helps assure dilution of the damaging chemical until the victim can reach medical help. Application
of neutralizing chemicals is not generally recommended without specific directions from qualified medical personnel.

Eighteen percent (55 of 300) of participants knew the recommendation of the National Science Teachers Association (NSTA), and now supported by numerous other science education professional science organizations, for class/lab size limitations. The NSTA suggests a minimum of 5.5 square meters per student in a combined classroom/laboratory and four square meters per student in a separate lab area. Because of safety considerations and the individual attention needed by students in laboratories, science classes should be limited to 24 students in elementary, middle level, and high school science labs unless a team of teachers is available. In addition, “a minimum of one square meter of laboratory space per student” is recommended.

The Council of State Science Supervisors in its Exeter III report recommended 24 students as a limit. The Texas Education Agency recommends 60 sq. ft. of floor space per student (includes teacher prep areas, store rooms) and a maximum class size of 24 in the high school science labs.

Jay Young, safety expert, suggests that 25 is a maximum for the number of persons in a laboratory. In 1972, Young indicated that the accident potential for a class increases when the square feet area per student falls below 41.

Louie DiBerardinis states that experience shows that 32 ft$^2$ per student is an absolute minimum for a teaching laboratory. And this minimum assumes that other aspects of the design allow ideal placement of hoods and adequate circulation about and egress from the room during an emergency.

The architect will generally note the student capacity of the room based upon its physical dimensions. In many instances, the capacity will be premised upon the number of work stations that the plumbing, electrical outlets, and gas jets can accommodate in addition to the square footage area of the room. Teachers should be cautious not to exceed the suggested capacity of the room if laboratory activities are to be a regular part of the science courses to be taught there. Physics labs, for instance, that are capable of producing ignition sources should not, ideally, be combined with chemical laboratories that use flammable liquids and gases.

The Uniform Fire Code classifies science laboratory classes as academic subjects and specifies 20 sq. ft./student. The California Administrative Code, Title II, subchapter 4, section 18111(a) requires the state architect to design labs with 1300 sq. ft. of floor space (including preparation and storage space) for 26 students in grades 7-12 or 24 students in grades 9-12 (50 or 54 ft$^2$ or 4.5 m$^2$ or 4.9 m$^2$ per student respectively). The California Department of Education suggests that the following items be considered when making this decision: “1. the number of students that one teacher can supervise in a potentially dangerous activity, 2. the degree of personal risk, 3. the increased liability when class size exceeds 24 students, 4. the level of maturity and knowledge of safety that students bring to the science laboratory, 5. the space required for each student to perform experiments safely.”

**Chemical Management Issue**

This section of the assessment encompassed chemical labeling, storage, and hazard assessments.

Twenty five percent (74 of 300) of participants knew that chemicals are best stored by chemical family. This method helps eliminate unwanted chemical reactions in the event of container breakage, it facilitates chemical association to properties, and it helps assure compliance with “Right-to-Know” and “Chemical Hygiene Plan” requirements.

Only 1% (3 of 300) of participants could identify the major requirements of the OSHA Hazard Communication Standard or “Right-to-Know” (RTK) Legislation, pertaining to hazardous chemicals in the workplace. This legislation was originally drafted as Final Rule in 1983 and became effective November 25, 1985. The standard can be found in Title 29 of the Code of Federal Regulations in Subpart 2 of Part 1910 (Federal Register, November 25, 1989 and August 24, 1987). This OSHA regulation, similar to many others, have compliances based on national consensus standards from such organizations as the American National Standards Institute (ANSI), National Fire Protection Association (NFPA), and the Department of Transportation (DOT).

All privately financed educational institutions are covered by the federal standard as well as the Right-to-Know laws in force in their respective states. Publicly funded schools must comply with their respective state government statutes. All RTK legislation is designed to help employees recognize and eliminate the dangers associated with hazardous materials in their workplace. The legislation requires that a written program be developed and that all affected employees know it’s contents. The details of such legislation will vary from state to state. Check with your Department of Education, federal (Chemical Emergency Procedures and Right-to-Know questions 1-800-424-9346) or state OSHA office, or Department of Labor. The plan need
not be lengthy; however, it must include these components:

1. Written Hazard Assessment Procedures, including: designation of responsible individual(s) or agency, consideration of scientific evidence for health hazards, evaluation of physical hazards, consideration of regulated chemicals, and assessment of chemicals prepared on site.

2. Material Safety Data Sheets (MSDS's), including: designated person responsible for maintaining the sheets, procedures for apprising and allowing employees access to them, procedures to follow when MSDS's are not received, procedures for updating the sheets, and descriptions of alternatives to actual sheets in the work area.

3. Labels and Warnings, including: designated person responsible for ensuring proper labeling of chemicals, description of labeling system, and procedure for updating the labeling information.

4. Employee Training, including: designation of person responsible for conducting training, format of the program, documentation of training, and procedures for training new employees. The ultimate purpose is to assure a safe workplace.

A 1991 electronic survey of the 50 state departments of education, by Gerlovich, indicated that 39 states currently recognize either the federal or state versions of the RTK legislation. States with their own version of the RTK must assure that the guidelines are at least as stringent as those of the federal government in protecting employees from hazardous chemicals.

Only 1% (4 of 300) participants could identify the major components of the OSHA Chemical Hygiene Plan (29 CFR, 1910.1450). As of January 31, 1991, laboratories engaged in activities that are encompassed within the definition of “laboratory use” must have in place a written Chemical Hygiene Plan (CHP) outlining how the facility will comply. This OSHA standard applies to all employers engaged in the laboratory use of chemicals. “Laboratory use” means:

- chemicals are manipulated on a laboratory scale where the chemicals are handled in containers designed to be safely and easily manipulated by one person;
- multiple chemical procedures are used; procedures are not of a production process;
- protective laboratory equipment and practices are in common use to minimize employee exposure.”

The legislation became effective January 31, 1991. The plan requires that employers, including schools, develop a comprehensive plan for identifying and dealing with chemical hazards. The plan must include all employees who could be exposed to these chemicals and it must be updated annually.

Legal Issues

This component of the assessment focused on legal issues which educators must understand to help avoid negligence and potential liability surrounding accidents involving their teaching.

Forty-five percent (136 of 300) of the participants knew nothing about tort law and its focus upon personal physical injury cases. The remainder of the legal issues addressed all focus on components of tort law in education.

Nine percent (27 of 300) of the participants knew that “sovereign immunity doctrines” were once used effectively as legal defenses for teachers in tort negligence cases. Sovereign immunity is a carry-over of British law which states that certain parties were sovereign and thus immune from negligence suits. At one time government agencies, including schools and its employees, were covered by this immunity. It is very rare today, having been superseded by insurance and “save harmless” provisions to tort law.

Only 8% (25 of 300) of the participants knew that the “save harmless provision” is currently used as a powerful defense for educators in tort negligence cases. The save harmless provision is nearly universally applied in all states. It generally states that accidents can happen, parties can be injured by educators, and law suits can be filed against the educator. However, unless it can be proven that the educator broke the law (goggle legislation, Right-to-know legislation, etc.), or were grossly negligent (violated well accepted professional or manizational guidelines, established codes, department of education standards, etc.), they would be defended to the limits of the resources of the school district or state.

Twenty-two percent (66 of 300) of participants could explain what constituted negligence in science education. Generally speaking, negligence is defined as conduct which falls below a standard set by the law or one’s profession to protect others from injury. Lack of “due care” is another legal synonym. Educators must conform to the civil laws of society as well as applicable codes (fire, electrical, plumbing, etc.) and standards (professional standards of performance, state Right-to-Know, Chemical Hygiene, Bloodborne Pathogen legislation, etc.) in order to assure a safe teaching and learning environment.
Only 6% (19 of 300) of participants knew that “due care” was a synonym for assuring that the educator was not negligent, and that it consisted of satisfying three major duties. First, is Instruction appropriate for ALL students in one’s charge (inclusion or special education students, students with special medical needs, etc.)? Second, is Supervision adequate for the situation, surroundings, student population being served, and activities being conducted? Is the environment (equipment, instructional surroundings) properly Maintained? Satisfying these duties helps assure that the educators in charge are not negligent should an accident occur.

Conclusions

There is little doubt that moral, ethical, and now legal responsibilities of science educators have increased in the past 10 years. Education has become a recognized profession by a good part of our society. As such, the public expects certain levels of knowledge, conduct, and foreseeability on the part of those employed within this profession. They also assume that science educators will keep themselves informed concerning recent advances in their field, especially if such information relates to the safety of their children.

This study indicates that there is reason to suspect that the level of basic knowledge of many science educators is marginal at best. Is this the fault of teacher preparation programs for not requiring such education as part of their graduation requirements? Or is it the fault of inservice training programs for not making the information more readily available to professionals? Or could it be that state licensing boards are not doing their jobs by allowing licensure without such information? Or are science educators themselves at fault for not demanding such training? It appears that all of these organizations and professionals bear some of the responsibility for seeing that science is taught to students in an effective and safe manner.

There is little purpose served by pointing fingers of fault. We must recognize that safety in science teaching is a huge undertaking and requires a cooperative effort from ALL parties involved—professionals, government, the courts, parents, and even students.

For the purposes of this study, it was revealing to discover what science education professionals actually know regarding science safety. More importantly it indicated that much more research is needed in this area of safety understandings and perceptions.

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Science Education International, Vol. 6, No. 3 September 1995

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**ASE ANNUAL MEETING**

**January 4-6, 1996**

**The University of Reading**

The Association for Science Education will be holding the 1996 Annual Meeting at the University of Reading next January. Reading is the most accessible of venues for those coming by air. There is a direct rail service from Gatwick Airport and a direct coach service from Heathrow.

Although the meeting officially starts on January 4th, there will be a special International Seminar organised jointly by ASE and ICASE on Wednesday, January 3rd. The subject will be "Continuing professional development of the science teacher" and contributors are very much welcomed. There will be accommodations available on Tuesday, January 2nd, for those attending.

As well as the British Council symposium and an international reception, there will be hundreds of sessions to interest and inspire, whatever the level—primary secondary, tertiary, or higher education.

Advance information and registration forms are available from:

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Association for Science Education
College Lane
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UK
Fax: +44 1707 266 532
Industry-Education (ELF Sponsored)
Location: Paris

Science Centre Conference
Location: Finland

January 4-6, 1996
ASE Annual Meeting
Location: University of Reading
Contact: Iris Sinfeld
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College Lane
Hatfield
Herts AL10 9AA
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Fax: +44 1707 266 532

January 5-10, 1996
GASAT 8 International Conference
Location: Ahmedabad, Gujarat, India
Contact: Jayshree A Mehta
Conference Chair/Convenor
GASAT 8 Secretariat
SATWAC Foundation
A1/22, Amrapali, Sukhipura,
New Shardamandir Road,
Paldi, Ahmedabad-380 007, INDIA
Tel: 91 79 428991, Fax: 91 79 416941

January 21-25, 1996
3rd International Interactive Multimedia Symposium
Location: Perth Western Australia
Contact: Promaco Conventions Pty Ltd
ACN 008 784 585
PO Box 890, Canning Bridge, Western Australia 6153
Tel: (61) (9) 316-1453
e-mail: promaco@cleo.murdoch.edu.au

February 7-9, 1996
International Consortium for Research in Science and Mathematics Education (ICRSME) 6th Consultation

Location: Belize City, Belize
Central America
Contact: Dr. Arthur L. White or Dr. Donna F. Berlin
The National Center for Science Teaching and Learning (NCSTL)
Room 100
Ohio State University
1929 Kenny Road
Columbus, OH 43210-1015 USA
Tel: (614) 292-3339, Fax: (614) 292-1595

March 28-31, 1996
NSTA National Conference
Location: St. Louis, MO, USA

May 28-31, 1996
14th Dortmund Summer Symposium
Theme: Educational Research in Chemistry and Physics Education
Contact: Dr. Hans-Jürgen Schmidt
University of Dortmund, Dept. of Chemistry
Otto-Hahn-Str. 6
43221 Dortmund, Germany

The main aim of this conference is to discuss the methodology of empirical research in this field.

June 14-18, 1996
Science Centre Conference
Location: Finland
Contact: Ms. Helena von Troil, Secretary General
Heureka, The Finnish Science Centre
PO Box 166
FIN-01301 Vantaa, Finland
Tel: +358 0 85799
Fax: +358 0 873 4142

The Association of Science-Technology Centres (ASTC) and the European Collaborative for Science, Industry and Technology Exhibitions (ECSITE) invite science centre professionals from all over the world to the FIRST SCIENCE CENTRE WORLD CONGRESS to be held at Heureka the Finnish Science Centre in Vantaa (Helsinki), Finland. The congress will give opportunities to learn and share the experience of colleagues from all over the world.
July 14-19, 1996
14th International Conference on Chemical Education
Location: Brisbane, Australia
Contact: The ICCE Conference Secretariat
(Sally Brown), Continuing Professional Education,
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Tel: (07) 365 6360 Intl: +61 7 365 6360
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The 14th ICCE will be held in Brisbane from July 14-19, 1996. It is only the second time this conference has been held in the southern hemisphere. The biennial conference brings together chemistry teachers, chemists and science educators from school, industry and university settings to share ideas and learn from one another about innovation in teaching and learning and the discipline of chemistry. The theme, Chemistry: Expanding the Boundaries, acknowledges the centrality of chemistry through its expanding relationship with many facets of science and everyday life. Conference participants will be challenged to develop this theme with the view of enhancing our understanding of the important relationships which chemistry forms with the new frontiers of human endeavour. Implications for chemical education beyond 2000 which give a “science for all” perspective will be encouraged.

August 4-8, 1996
14th Bicentennial Conference on Chemical Education
Location: Clemson University, Clemson, SC
Contact: DeWitt Stone, BCCE General Chair, 206 Sikes Hall, Clemson, SC 29634-5170
Fax: (803) 656-1515; e-mail: bcce@clemson.edu
WWW address: “http://tigerched.clemson.edu”

The Planning Committee has selected “Chemistry: The Challenge of Change” as the conference theme. The uses of computers and multimedia technology in chemistry teaching will be a particular focus of this conference. Another focus will be topics such as biotechnology, polymers, textiles, advanced materials, and environmental science—fields in which chemistry overlaps with the interests of other disciplines.

November 1996
Australian Model Solar Car Challenge
Location: Adelaide, Australia
Contact: Brenton Honeyman, Chair, AMSCC
The National Science and Technology Centre
King Edward Terrace, Canberra ACT 2600
Tel: (06) 270 2816
Fax: (06) 273 4346

In November 1996 students from across Australia will meet in Adelaide to compete in the Australian Model Solar Car Challenge, the culmination of state-based challenges conducted from September to November in New South Wales, Victoria, Queensland, South Australia, Western Australia, Tasmania, and the ACT.

December 27-30, 1996
NSTA International Convention
Location: San Francisco, CA
The convention, to be chaired by NSTA Executive Director Bill G. Aldridge, will bring together scientists and K-college science educators from dozens of science and science education societies and organizations worldwide. Invitations have already been sent to societies in more than 30 countries. Holding the event in San Francisco, it is hoped, will especially encourage participation from Pacific Rim countries.

At this convention, participating teachers and science educators will present sessions in their areas of expertise (interdisciplinary approaches are encouraged) to scientists who are not as familiar with the classroom. In turn, scientists will present sessions about their work to nonspecialist scientists and to educators less familiar with the latest news from the research laboratory.

1997

South African Conference
Eastern Europe Conference
10th ICASE-Asian Conference
Location: Lahore, Pakistan
Extending and Improving Education in Science for All Children and Youth by Assisting Member Association Throughout the World

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Science Education International is the Quarterly Journal of the International Council of Associations for Science Education. ICASE was established in 1973 to extend and improve education in science for all children and youth by assisting member associations throughout the world.

This journal provides a means for associations, institutions, centres, foundations, companies and individuals concerned with science education, to share perspectives, concerns, ideas, and information which will foster cooperative efforts to improve science education, and which will serve as a chronicle of the advancement of science education throughout the world.

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March 1 February
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ICASE News
Partners in Chemical Education 2
The Challenge 2
New Member 3

Feature Article
New Challenge in Science Education 4
Science Education Around the World
Context-Related Curriculum Planning 10
Research on Curriculum, Teaching & Learning
A Discussion List in a Science Methods Course 17
Teaching Materials & Strategies
An Alternative for Scientific Formation 19
Science Teacher Education & Leadership
How Do You Know That:
An Epistemological Challenge? 21
Concept Mapping: A Ghanaian Secondary School Student's Experience 24
Non-formal and Informal Science Education
Investing in Professional Development 29
NSTA Proposal Application 33
NSTA Minimum Safety Guidelines 35
Calendar 38

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PARTNERS IN CHEMICAL EDUCATION: AN INTERNATIONAL CONFERENCE ON INDUSTRY-EDUCATION INITIATIVES IN CHEMISTRY

The Partners in Chemical Education Conference was held August 27-September 1, 1995 at the University of York, York, UK. Pictured below is Professor David Waddington, Chemistry Professor at the University of York, who hosted the conference, and Anna Garner, ICASE President Elect.

THE CHALLENGE

Jack Holbrook

ICASE continues to promote Project 2000+ to its member organisations and encourage them to undertake activities to promote scientific and technological literacy for all (STL) among its members. The 21st century is very close and the Project 2000+ Declaration, put forward as a worldwide goal, states that “appropriate structures and activities should be in place by the year 2001 to foster scientific and technological literacy.” ICASE, as a member of the Project 2000+ international steering committee, supports this declaration and recommends it to its members.

It is the meaning attached to “scientific and technological literacy” and “how this can be attained” that is at the heart of the challenge. It seems there is a big gap between “teacher-centred instruction” and “the development of skills and values in student-centred classrooms considered necessary for enhancing scientific and technological literacy for all.” And it is the “FOR ALL,” i.e., necessary for all students, that is of particular importance.

How do we get the average teacher to accept this meaning and embrace STL in their classrooms? How can we get teachers to

- realise that science education is not simply the acquisition of facts, concepts or even the process of being a scientist.
- to accept that there is a values education component to science education and this is embedded in the intended curriculum
- realise that student learning needs student involvement (involvement in homework, classroom thinking, investigating through experimentation, writing, communication in general, in solving societal problems which encompass science and in making societal decisions in which science has a part to play).
- realise that in areas where students proceed slowly and need help (planning approaches/investigations, carrying out experiments, analysing data and opinions) need more
attention not less in the teaching process, more practice is appropriate, not less.

• realise that statements by the teacher, such as “I need to finish the syllabus” have no meaning. At best it draws attention to the gap between the teacher’s teaching and students’ learning. To guide the students to complete the syllabus is much more in keeping with STL.

ICASE cannot do this. ICASE is an umbrella for its member organisations. ICASE can only encourage and support its member organisations to find ways to promote scientific and technological ideas to its members and to consider ways in which this can be made more meaningful to teachers in their day-to-day teaching.

Here are some possible ways to reflect on STL. (Does your organisation agree? Is your organisation promoting any of these? If so, how? Why not write an article in the ICASE journal?)

• make teaching more student-centred
• increase meaningful feedback from students through written, verbal, graphical, diagrammatical, manipulative, attitudinal mechanisms
• increase higher order thinking within the classroom (students need to think). It is insufficient to simply state or predict observations. This is but a small part of science education. It is certainly insufficient to follow a recipe (such as worksheet instructions)
• teach from the application or concern or issue to the concept
• teach from the familiar and from what students know of this to the unknown (don’t teach what they already know)
• teach in a logical sequence, BUT LOGICAL FOR THE STUDENT, not simply according to scientists (e.g., chemistry is not necessarily microscopic ideas. Only if it can be related directly to an area of relevance to society is a sequence recommended.).
• if a topic (or part of a topic) is too difficult for the students, leave it out. [The topic can always be revisited later.]
• teach the students. Don’t simply quote the textbook. The textbook is science ideas. It is not science education. The students need education. Science is the vehicle for this education. The textbook is an aid, not the substance.

May 1996 be a challenge and rewarding year as we each face these and many other educational challenges.

ICASE WELCOMES THE CHINESE SCIENCE EDUCATION SOCIETY

The Chinese Science Education Society has been accepted as a full member of ICASE. The society was founded in 1988 and is a nationwide academic community. The society consists of 480 members with professors, teachers, officials, and some student members. Most of their members are active leaders in the field of science education for academic research, service, and national policy formation. The activities include the annual Science Education Conference, publications of conference proceedings, and the Chinese Journal of Science Education. In the past, they have selected many outstanding young scholars to attend the international conferences and assessed science education research programs under the authority of the Ministry of Education.

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NEW CHALLENGES IN SCIENCE EDUCATION:  
THE BIRTH OF "PRIME" SCIENCE

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Introduction

Prime Science is a major new development in science education in the United States. It is a course for Grades 6-10 which is being designed by two groups, one at the University of California, Berkeley and the other at the University of York, UK. In this paper the history of the project is traced against the background of fundamental changes in science education which are occurring in the US and UK, pointing out the similarities in thought and delivery of national guidelines.

PRIME Science is a multidisciplinary course, encompassing astronomy, biology, chemistry, earth sciences, geology, and physics from Grades 6 to 10 which is being developed by a team of practising science teachers from universities and schools in the two countries; it is probably the first international endeavour in curriculum development in science on such a large scale. The course responds to the challenge of the AAAS Project 2061, NSTA’s Scope, Sequence and Coordination Project, and initial documents from the National Science Education Standards, both in terms of content and assessment; and it can be adapted readily to recent state frameworks.

Why should teachers from the US and UK come together to produce a science course? It is more usual to learn from each other during visits and conferences, and through the literature. What are the advantages of actually working together?

National Changes in Science Education

The US and UK are undergoing similar fundamental changes in their national educational strategies, focussed by political debate. One of the most important elements in this strategy, the enhancement of the role of science and technology education in the school curriculum, is at the core of the debate. Further, there is an extraordinary similarity in the two countries on the problems facing science education in schools.

There has also been a similarity in the way the political and educational debates in the two countries have unfolded. In the UK, James Callaghan, then Prime Minister, opened the discussions in 1976 in a speech which emphasized that the increasing complexity of modern life meant that standards in many areas, including education, needed to rise (Callaghan, 1976). It initiated a national debate, on four issues: the curriculum, the assessment of standards, the education and training of teachers and the relationship between school and working life (DES, 1977). One strand in the debate was the provision of science education for all, which would not only empower all students to live in an increasingly scientific and technological society but also enable and encourage intellectually able students to pursue careers based in these subject areas.

In England and Wales, reports on science education from the Department of Education and Science and Her Majesty's Inspectorate (HMI, 1981; DES, 1982, 1985, 1987) enhanced a wide-ranging discussion which included major contributions from the Association for Science Education (ASE, 1979, 1981) and the Royal Society (Royal Society, 1982). There was general agreement that science should be taught throughout a child’s period of statutory education (age 5-16) and that by the time the child was 11 years old, 10% of curriculum time should be devoted to science, climbing to 20% by the age of 14. From these discussions arose the National Curriculum in Science (DES, 1989a, 1991a; DfE, 1995), given statutory status in the Education Reform Act of 1988. The National Curriculum in Science is now organized around 4 attainment targets. For each attainment target, there are programmes of study which describe what the students should be taught (DES 1989b, 1991b, 1994). For assessment, each attainment target is described by statements of attainment at different levels.

Meanwhile, a similar concern was being raised in the United States. In A Nation at Risk in 1983, the

If we want America to remain a leader, a force for good in the world, we must lead the way in educational innovation. And if we want to combat crime and drug abuse, if we want to create hope and opportunity in the bleak corners of this country where there is now nothing but defeat and despair, we must dispel the darkness with the enlightenment that a sound and well-rounded education provides.

The teaching of science and mathematics were seen to be at the heart of the change needed (US DoE, 1991), echoed in other key reports (Carnegie, 1991; NCESS, 1992), all very similar to the UK debate.

Between the publication of A Nation at Risk and the Bush goals, two initiatives were getting under way. In 1985 the American Association for the Advancement of Science began Project 2061. Phase I produced Science for All Americans (Rutherford & Ahlgren, 1989) a detailed analysis of what a high school graduate should know: which deals with learning goals, what students should remember, understand and be able to do after they leave school. The second phase involves a compilation of ‘bench marks’ which may be used for creating a meaningful science curriculum. In a separate action, the National Science Teachers Association began its Scope, Sequence and Co-ordination Project, publishing The Content Core: A Guide for Curriculum Designers Volumes I and II (NSTA, 1992). Both reports were notable for advocating what in the UK is called a balanced science approach, namely teaching all the natural sciences, year by year to all students.

In 1991, the US National Research Council, through the National Academy of Sciences, formed a Committee on Science Education Standards and Assessment. Results from its preliminary work are explicit; science instruction should include biology, chemistry, earth/space science and physics every year for every student.

In contrast to the more detailed UK National Curriculum for Science, this US framework is organized simply in three grade groupings K-4, 5-8, 9-12 without levels of attainment. As in the UK, there is emphasis both on the nature of, and applications of science which include knowledge of the inquiry process, the ability to design and carry out an investigation, perspectives associated with critical thinking or ‘habits of mind,’ and other positive attitudes usually associated with learning.

Making it Happen

The University of York Science Education Group went beyond the question of what science should be taught to explore the question of what it would mean in practise to provide such a curriculum. As a result of this work, four new science courses were developed which are now being used extensively in UK schools, Science Focus: the Salters Approach (for Grades 6-8) (UYSEG, 1990, 1992, 1993), Science: the Salters Approach (for Grades 9-10) (Campbell et al., 1990; Ramsden et al., 1992), Chemistry: the Salters Approach (for Grades 8-10) (UYSEG, 1989; Hill et al., 1989a, 1989b) and Salters Advanced Chemistry (for Grades 11-12). The uptake by schools is, at present, rapidly expanding in the UK, Trials of the materials are taking place in many countries including the Netherlands, New Zealand, Spain and Russia and one of the courses has been translated for Belgian schools (Brandt, 1993, 1994).

In this paper, we first describe the Science Foods and Science: The Salters Approach programs, which, together, provide a multidisciplinary science education course from Grades 6-10. We then describe steps taken to create a program for the US: the PRIME Science program, based on the Science Focus and Science: The Salters Approach materials.

The Development of the Salters Approach

Science Focus and Science: The Salters Approach were developed over a period of nine years by school teachers, university educators, university scientists, and industrialists, in a collaborative venture based at the University of York (Campbell et al., 1994).

The starting points for lessons were different from those usually used. Traditional starting points for curriculum development are the concepts in science which textbook writers and teachers know are important to their subjects. For example the Classification of Living Things, Gravity and the Periodic Table have often been used as the titles for textbook chapters. The teacher begins a topic by introducing these ideas, and from time to time gives examples of how they can be applied. What if the order were reversed? Could not the issues and applications of science with which students are familiar, or which they can recognise will be of significance to them in the future, be made the starting points for study? Could not scientific theory arise as these issues and applications are explored through student investigations? We believed that if the students’ interest has been captured they will
work harder to understand the concepts. Thus, we considered the following criteria (Lazonby et al., 1992; Campbell et al., 1994):

(i) Relating the course material to life experience:
Base the content of the course on something from a students life that students have experienced either first-hand or through the media.

(ii) Allowing concepts to emerge from the context:
Introduce the underlying science concepts only when they are needed to help the student understand the topic;
Develop the content at a level appropriate to consider what students might bring to the course at that age;
Link concepts to a context that students perceive as important. Thus social, economic, industrial and technological aspects of science pervade the whole course.

(iii) Encouraging active learning and exploration:
Involve students in a wide range of activities which encouraged them to learn through active personal experience, rather than simple passive listening;
Keep students involved throughout the course by using a wide range of cooperative learning strategies such as: laboratory activities; small group discussions; creative writing and reporting; role-playing exercises for discussing value-related issues; exploration of various other decision-making activities.

Constructivist theories and research on the role of student talk in the learning process (Driver, 1988) encourage use of opportunities for discussion in a meaningful context. Furthermore, the students participate in a broad variety of activities. The new courses make students get involved in expressing their understanding of concepts; planning investigations; discussing implications of data; considering social and economic issues. The teachers' role is to provide and lead students through a variety of opportunities to learn about the science as much as to teach students directly.

Using these criteria, 27 units were produced for Grades 6-8 (Science Focus) and 23 for Grades 9-10 (Science; The Salters Approach) (Tables 1 and 2). Each unit revolves around a topic the students will already be familiar with, or ones which they quickly realise to be of significance to students. The scientific principles then emerge during discussions. For example, ideas about rates of reaction are introduced to develop an understanding of food decay in the unit Food and particulate theory is used in the unit Drinks to explain ideas about states of matter in the context of the drinks we consume. The use of bicycle helmets provides the context used to introduce the concept of pressure in the unit Moving On; space travel gives the opportunity in Earth in Space to examine the atmospheric composition of other planets; digital signals emerge in Sound Reproduction in the context of disc players; safety signs on trucks, an international language leads, in Transporting Chemicals, to another international language-chemical symbols and formulas; fire prevention is the context, in Fire, Friend or Foe, for a study of combustion; germination is introduced in Full of Beans in terms of supplying fresh vegetables all year round and the role of medicines which we use is a context in Keeping Healthy to study the body's reaction to microbial invasion.

The course is challenging for both student and teacher. Content is set in new contexts, and a wide range of learning strategies is used. Therefore, extensive guidance for teachers is provided in the materials to make the contexts and strategies clear.

The design of the materials involved significant participation by teachers. The most important criteria were that the published materials should accomplish the following:

- Give teachers a quick overview of the units within the course
- Provide detailed guidance and support for inexperienced teachers or those teaching outside of their master area
- Delineate common student misconceptions and safety points
- Include suggestions for introducing discussions
- Include suggestions for the extension and evaluation of activities
- Present a structure and format that encourages more experienced teachers to begin the process of continual review, renewal, and development of the course.

Teaching material is organized as unit guides for the teacher's use. Each begins with an overview of the unit and an overall lesson-by-lesson plan. These satisfy the first criterion.

An outline is given for each lesson in the unit—which identifies the activities, outcomes, and skills used—and satisfies the second criterion. More extensive notes follow each lesson giving further guidance; for example, in suggesting interesting questions for prompting discussion. Masters, with limited copyright for student activity guides and information sheets, are also included.
Table 1

Science Focus: The Salters Approach (Grades 6-8)

<table>
<thead>
<tr>
<th>Grade 6</th>
<th>Grade 7</th>
<th>Grade 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>Body Care</td>
<td>Current Thinking</td>
</tr>
<tr>
<td>Having Babies</td>
<td>Child's Play</td>
<td>Drinks</td>
</tr>
<tr>
<td>Making Sense of IT</td>
<td>Conditions for Life</td>
<td>Food</td>
</tr>
<tr>
<td>Neighbours</td>
<td>Fire, Friend and Foe</td>
<td>Green Machine</td>
</tr>
<tr>
<td>Out of this World</td>
<td>Full of Beans</td>
<td>Growing Up</td>
</tr>
<tr>
<td>Paper Chain</td>
<td>Music and Noise</td>
<td>Metals</td>
</tr>
<tr>
<td>Skin Deep</td>
<td>On the Rocks</td>
<td>Safe as Houses</td>
</tr>
<tr>
<td>Switching On</td>
<td>Seeing the Light</td>
<td>Safe Journey</td>
</tr>
<tr>
<td></td>
<td>Wear and Tear</td>
<td>Seeing Stars</td>
</tr>
<tr>
<td></td>
<td></td>
<td>World Watch</td>
</tr>
</tbody>
</table>

Table 2

Science: The Salters Approach (Grades 9-10)

<table>
<thead>
<tr>
<th>Grade 9</th>
<th>Grade 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction Materials</td>
<td>Controlling Change</td>
</tr>
<tr>
<td>Energy Matters</td>
<td>Energy Today and Tomorrow</td>
</tr>
<tr>
<td>Food for Thought</td>
<td>Making Use of Oil</td>
</tr>
<tr>
<td>Keeping Healthy</td>
<td>Seeing Inside the Body</td>
</tr>
<tr>
<td>Moving On</td>
<td>Sound Reproduction</td>
</tr>
<tr>
<td>Transporting Chemicals</td>
<td>Waste Not, Want Not</td>
</tr>
<tr>
<td>Balancing Acts</td>
<td>All Systems Go</td>
</tr>
<tr>
<td>Communicating Information</td>
<td>Burning and Bonding</td>
</tr>
<tr>
<td>Electricity in the Home</td>
<td>Evolution</td>
</tr>
<tr>
<td>Mining and Minerals</td>
<td>Sports Science</td>
</tr>
<tr>
<td>Restless Earth</td>
<td>The Earth in Space</td>
</tr>
<tr>
<td>The Atmosphere</td>
<td></td>
</tr>
</tbody>
</table>

The third criterion is met by producing the unit guides in loose-leaf form. The unit guides provide the basis from which schools develop individualized teaching schemes. Lessons and parts of lessons can be modified and replaced by the teacher. It is not possible to provide for the needs of all students with a single set of worksheets, so advice is given for adapting activities for a variety of levels of attainment. Colorfully illustrated student books support the unit guides. Each chapter is based on one unit and contains five parts: a one-page student-level introduction, a collection of several text-related activities illustrating applications and uses of scientific ideas, a quick reference summarizing important points, an explanation of the scientific ideas and a collection of suggested activities for home, library, club or school, including sample test questions.

Written materials for activities for younger students are needed, which are much more highly illustrated and for units for Grades 6-8 (Science Focus) are in individual booklets entitled ‘Working with Science’ and ‘Looking into Science’ (UYSEG, 1993).

As described above, the National Curriculum for Science in the UK sets out in some detail the progress that students might be expected to make both in terms of their knowledge and understanding and of their investigational skills. Each of the unit guides contains detailed guidance and sample assessment items to assist teachers in monitoring their students’ progress in all of these areas. At the age of 16, students are also required to take examinations which are written, marked and graded by examination bodies external to the schools.

In spite of the radical nature of the Salters Approach, schools in the UK have been adopting the
course at a rapid rate, particularly when it must be remembered that it leads to an examination which is moderated nationally, and thus many teachers may baulk at the idea of putting students “at risk.” That they have not is a signal of confidence. Forty thousand students in the UK took the examination set at the end of Grade 10 in 1995, with more expected to take it in subsequent years.

The Development of PRIME Science

The similarities in the science education debate in the UK and US set the scene for an exciting new collaboration which will deliver a multidisciplinary course for grades 6-10. It began with a three-year feasibility study which included many discussions with leading US science educators and then with two one-week workshops in California.

Ten teachers from California schools and six from the development team at the University of York worked together on about eight of the units at each workshop to get a feel of the adaptations and additions necessary for US classrooms. The resulting materials have been tested in schools. Parallel to this, several schools in Oregon have evaluated the UK version of the materials as part of a research and development study (Borgford et al.). In July 1992, 10 US teachers went to York for a third workshop. Some participants had experience of the Californian workshops, giving valuable continuity. Having this workshop in the UK enabled the US team to watch the program in action in British classrooms and to talk to teachers experienced in the program.

Detailed criteria for the PRIME Science program were then developed. This program uses some of the best science teachers and educators in the US to rewrite, update, and localize each activity and each unit of the program in collaboration with the original UK team. This involves not only language and factual information embedded in the units, but changes in lesson duration, equipment for activities, safety regulations, support and reference materials, and matching content to state and national knowledge bases.

Adaptation workshops are being held in 1994 and 1995 in six states, California, Colorado, Iowa, Massachusetts, South Carolina, and Tennessee. Each site gave a unique perspective and orientation for the adaptation. Between workshops, teachers involved in them are trialling the materials. In 1995, teachers from all six states were brought together in Berkeley to undergo training in dissemination.

What is most significant about the program is that not only are major scientific concepts and skills developed over the five-year school period with sensitivity to the developmental level, but also starting lessons with a topic which is of immediate interest or easily recognized as being highly important to a student’s life. Teaching the science behind that topic through exciting student experiences is motivational and effective.

Acknowledgement

We wish to thank the National Science Foundation for funding to make possible the creation of PRIME Science and the hundreds of teachers in the US and UK who have given their time in writing and trialling the resources.

References


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CONTEXT-RELATED CURRICULUM PLANNING:
USING THE OZONE PROBLEM

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Universidad de Concepcion
Direccion de Investigacion
Concepcion - Chile

Introduction
Since Chile is a narrow and long country, where the so called dilution effect of the ozone layer jeopardizes most of the land from Punta Arenas (53 degrees South) to La Serena (33 degrees South), it is necessary to prepare its population for possible ecological consequences of UV-B radiation increase.

Scientists in Chile assume part of this task by studying short and long term effects upon the different ecosystems. Education also plays a role since the problem requires an attitude change in population.

The Ozone/UV-Radiation Problem—
General Information
In over 20 years of reports from several sources, indications are that the ozone concentration is gradually and permanently decreasing each spring over Antarctica. The so called OZONE HOLE is increasing in size. But since ozone is the only element which effectively absorbs solar UV radiation, the observed depletion of the ozone layer might negatively affect life in that region.

Punta Arenas, located at the edge of the Antarctic ozone hole, is the southernmost major city in the world (53.3 degrees South). Production activity in Punta Arenas is related to wheat crops, forestry, fishery, cattle, and especially sheep. The increasing damage in the ozone layer over the region could, therefore, cause larger exposure to UV-radiation, and reduce food production both in the South of Chile and Argentina.

Research results with several atmospheric models suggest that the ozone layer depletion is the effect of many trace gases from human activity, such as CFCs (chlorofluorocarbons), CH4, N2O and CO2. Worrisome questions are posed with respect to the biological consequences of the combined seasonal and year round ozone depletion above Punta Arenas. Scientists are looking for an answer to these questions, such as how to reduce the problem and how big are the consequences upon the health of living organism; how does the depletion affect the photosynthesis process, how do living or ganism respond and which are their adaptive mechanisms for short and long term UV-B radiation exposure events, among others.

There are also some educational questions which we, as science educators, could and should attempt to answer.

The Task for Science Educators
In Chile, science teaching has as its main goals to contribute to a better quality of life, to allow the students to give a positive direction to their life, and to allow them to turn into constructive members of society who know themselves and their environment.

Closely related to these objectives is the ozone-UV radiation problem. Therefore, science teaching should consider this issue and curriculum developers should accordingly organize science content to include the ozone-UV radiation problem each school year.

The rapidly thinning ozone layer has created widespread concern among people living in this region. Since its discovery, several surveys have been conducted because Punta Arenas, due to its unique position within the ozone hole, is a living prototype model most likely 10 years ahead of the rest of the world regarding photobiological change.

The Ozono Group in the Universidad de Magallanes (UMAG) is presently undertaking a range of studies related to the Antarctic ozone hole and ground level UV radiation. Studies by the UMAG
ozone group have already shown an increase in ground levels of UV radiation by as much as 400% during the time that the ozone hole lies above southern Chile. The group has established an effective system to coordinate the dissemination of the information they receive to the public.

A number of satellite systems are presently able to collect data on high altitude ozone concentrations and to transmit this to receiver stations located in different places around the world.

The UMSG ozone group has been studying the movement of the Antarctic ozone hole for the past decade. Estimates from UV-B radiation measurements show that in 1992 approximately a doubling of the average daily exposure was experienced in Punta Arenas on those individual days on which the ozone depletion was greatest presently represent the time frame for greatest exposure: September and October.

Even though a decrease in stratospheric ozone does not necessarily translate into an increase in the dangerous short-wave UV-B, large increases in ground level UV-B (100% above normal) have been measured in the recent years in the south of Chile and Argentina. These increases correlate with the measured decrease in the ozone column.

UV-light passing through the ozone hole could alter the balance of the species that make up the different levels of the ecosystem. Several studies have been conducted in an attempt to measure the damage done by the extra UV-B radiation coming through the ozone hole. In addition, a net of 16 stations have been installed in different cities in Chile and Argentina. These stations have been provided with two types of sensors for solar UV radiation.

The effect of the increases in UV-B radiation has been studied in wheat crops. Sea plankton has also been studied. A survey has been conducted to evaluate the consequences of a short-term increase in UV-B radiation upon the ocean water. The effect of UV radiation on animals and human beings has also been studied. Studies to date have found no acute or immediate impact on human health. This may be due to small sample size and the lack of any long-term exposure studies. Nor do any data show convincing evidence of acute eye disease associated with the ozone hole. Findings related to eye disease rates among shepherds and fishermen, who spend most of the time outdoors, and among hospital workers, are uncertain. Although sheep from several ranches showed higher rates of eye infections, researchers state that ophthalmic findings could not be related to the ozone problem.

The above information shows that although direct stratospheric measurements of the ozone layer are being registered, few systematic or concerted effort exist to relate such measures to actual health effects. Nevertheless, human immunology, skin cancer, cataract and the effects of UV radiation in the Antarctic region have been identified as priority research areas for populations exposed to ozone depletion conditions.

Several multidisciplinary teams have been formed and have designed pilot studies, such as described above, to identify possible health effects associated with the ozone hole over southern Chile.

There is no doubt that major and more accurate information is needed to successfully confront not only the potentially dramatic Antarctic ozone hole created by our civilization, but also the unforeseen problems reserved for our future world population.

Teaching in Context

Science educators are aware of these and other related issues which affect society. For some years science education has not only been seen as that curriculum component which provides the students with scientific knowledge and prepares them for future scientific studies, but also as an important component of their personal development. Science for all is the idea. Science for the citizen, science for daily life, science for the job, science for the scientist.

One of the problems which science educators must face is the students' lack of interest in science. From the application of an interest questionnaire developed at the Institute for Science Education (IPN), in Kiel, Germany, and translated to Spanish at the University of Concepcion, it has been possible to gather information. The questionnaire was applied to a sample of about 2,000 students from grades 5 to 12 in Concepcion. Results indicate that not many students show high or very high interest in the different topics of physics. While by grade 5 around 60% of students show interest, by grade 12, less than 50% are interested. A significant decrease appears along the school years.

However, this study has also shown that some topics attract the students better than others. The contexts which arise more interest in students are those related to health, environment, and society issues.

Chilean educational authorities are concerned about the lack of student interest in science-related professions. The 1995 admission process to universities showed many careers in the science and technology area (engineering, science teachers, among others) where vacancies of fered were not filled. Compared to the situation in 1984, the above
is especially worrisome. At that time applications were close to double the number of vacancies of ered. Critical is the case of Mathematics and Physics Teachers Training and Bachelors in Physics, where for each 10 vacancies there are only 4 to 8 applicants.

In an effort to revert the situation, modern approaches to science teaching have identified five contexts under which science should be taught. These are considered as suitable for someone living in our society as it is and as it will be tomorrow. "This 'someone' is everyone, male or female, beginning with the youth who has finished his schooling and is looking for an apprenticeship, and including the retiree who goes for walks in the park and whose favorite pastime is playing pinochle with his old friends" (Haussler et al., 1988, p. 2).

The suitable science education for this 'someone' means not only passing on scientific knowledge but also understanding scientific and technological developments and their consequences, recognising dangers arising from scientific and technological developments, avoiding sources of danger and accidents in daily life, knowledge of technical systems, appliances, etc., found in the home or used in maintaining a household, using positively the leisure time, positively integrating the social and public spheres, acquiring an understanding of the work world and the basic qualifications for employment. It also means personal emotional development, subjective satisfaction from learning about the natural sciences, personal intellectual development, and enlightenment. Corresponding to this view of science education, several topics were identified as suitable curriculum content for science courses.

The Chilean school science program, although divided into biology, chemistry, and physics, allow flexibility in choosing how to organize the content. We will discuss the physics curriculum structure and how teaching in context can be applied. The curriculum traditionally consists of basic content and optional modules where different applications are analysed. The teaching in context curriculum recommends not to start from the basic contents and discuss later (if possible) some applications, but to start from a real problem (a so-called application problem) and from there on to motivate the students to seek for explanations in the structures (concepts, laws, scientific processes or procedures, etc.)

This approach has proved successful in physics. It has been applied for three years by a group of teachers who collaborate with us at the University of Concepcion. They report that pupils show more interest than when working in a more traditional way. Achievement tests also show a satisfactory level of learning. Information gathered through an opinion questionnaire given to pupils indicates that they liked this approach. It is time to consider expanding this approach to include biology and chemistry. Table 1 describes the present science Chilean curriculum for secondary school (grades 9 to 12):

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Chilean Curriculum For Secondary School</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Physics</strong></td>
<td></td>
</tr>
<tr>
<td>Grade 9:</td>
<td>Energy transfer 1; Waves 1 (wave concept); Interactions 1 (force and pressure)</td>
</tr>
<tr>
<td>Grade 10:</td>
<td>Energy transfer 2 (heat and temperature); Waves 2 (bidimensional waves); Interactions 2 (collisions, momentum)</td>
</tr>
<tr>
<td>Grade 11:</td>
<td>Energy transfer 3 (mechanic energy, heat and work); Waves 3 (light); Interactions 3 (Newton laws)</td>
</tr>
<tr>
<td>Grade 12:</td>
<td>Electric energy; Atomic and Nuclear physics</td>
</tr>
<tr>
<td><strong>Biology</strong></td>
<td></td>
</tr>
<tr>
<td>Grade 9:</td>
<td>Health education; basis for biological balance in nature</td>
</tr>
<tr>
<td>Grade 10:</td>
<td>Unity and diversity in the living world; Energy and matter exchange between or ganisms and their environment</td>
</tr>
<tr>
<td>Grade 11:</td>
<td>Organic integration systems</td>
</tr>
<tr>
<td>Grade 12:</td>
<td>Reproduction and development of living beings; Inherited characteristics transmission</td>
</tr>
<tr>
<td><strong>Chemistry</strong></td>
<td></td>
</tr>
<tr>
<td>Grade 9:</td>
<td>Chemistry and nature (water, air, soil, energy)</td>
</tr>
<tr>
<td>Grade 10:</td>
<td>Nuclear chemistry and nature (natural resources, food, health, chemical industry)</td>
</tr>
<tr>
<td>Grade 11:</td>
<td>Chemistry, a science; Chemical reactions</td>
</tr>
<tr>
<td>Grade 12:</td>
<td>Organic chemistry; Redox reactions</td>
</tr>
</tbody>
</table>
Our proposal has the following main objectives:

A. To enable the person:
   - to perceive and to make judgments on the intimate connections between scientific and technological developments, on the one hand, and economic and political developments on the other;
   - to integrate scientific and technological developments with the science knowledge he/she already has;
   - to understand and to pass judgment on misdevelopments and their consequences for the environment;
   - to act with full awareness of his/her social responsibility and to reflect critically on what he/she is doing;
   - to discuss current problems and to translate one's own insights into socio-political action.

B. To make it easier for the person to meet the demands made in daily life, with knowledge and understanding of the ways in which technical objects function, in which one must deal with them so as to recognise sources of danger and to avoid accidents.

C. To enhance and guide the attitudes and feelings with which a human being confronts nature and technology and in this way furthers personal emotional development and to lead to the person's voluntary engagement with science for its own sake and in a subjectively satisfying way.

D. To pass on important parts of scientific knowledge, developing cognitive abilities as well as scientific methods of thought and conceptual schemas, providing also an accurate picture of the world and of the laws which govern it, thus contributing to the individual awareness and understanding of both the natural and the technological environment.

E. To impart the basic qualifications for many occupations and to give a glimpse into the technical work world and the occupations which are shaped by the science.

The ozone problem is a real problem in Chile and provides an excellent opportunity to help students make connections between the content of chemistry, biology, and physics. Table 2 shows the content of physics, chemistry, and biology as organized around the ozone hole problem.

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Table 2
The Proposal: Physics, Chemistry and Biology Basic Contents
Theme: The Ozone Hole, A Menace To The Quality Of Life

9th grade
1. The sun, our main source of energy
   1.1 The light of the sun allows the life in earth: photosynthetic activity and atmospheric CO2-O2 balance
   1.2 The light of the sun is a wave
   1.3 Waves transport energy
   1.4 Energy is necessary for human activity
   1.5 Different sources of energy
   1.6 Waves elements: speed, frequency, wavelength, amplitude
   1.7 Sun light consists on different wavelengths
   1.8 UV radiation is part of the sun light
   1.9 The effect of waves depends upon their wavelength

2. Air is important for living beings
   2.1 Air is composed by different elements
   2.2 Ozone is a component of the atmosphere
   2.3 Ozone protects the quality of life in earth
   2.4 Ozone uses energy from UV radiation and absorbs it
   2.5 Air is polluted by human activity
   2.6 Some air pollutants destroy the ozone layer

3. Food is necessary for our health
   3.1 Nature provides food for all living beings
   3.2 Living beings interact among others and with the environment
   3.3 Soil, water and air contribute to ecological balance
   3.4 Fresh food is important for our health
   3.5 The sun makes life possible but heat damages fresh food
   3.6 Cold allows to preserve food

Science Education International, Vol. 6, No. 4 December 1995
3.7 Industry contributes to preserve food
3.8 Industry uses different processes to preserve food
3.9 Food is preserved in freezers
3.10 Freezers design includes the use of some products which can damage the ozone
3.11 Science and technology seek substitute products for freezers design which do not damage the ozone

10th grade
1. Food is important for mankind
   1.1 Chemical industry contributes to food production
   1.2 Food provides energy
   1.3 The sun provides heat energy
   1.4 Heat transfer is important for the atmospheric behavior
   1.5 Atmospheric pollution is affected by atmospheric thermodynamic processes
   1.6 Ozone concentration in the atmosphere is affected by climatic conditions
   1.7 Ozone filters UV radiation coming from the sun
   1.8 Much of our food comes from the ocean water
   1.9 UV radiation penetrates the water
   1.10 UV radiation alters life in water systems
2. The UV radiation and the electromagnetic spectrum
   2.1 Waves are reflected, refracted, diffracted and absorbed
   2.2 Electromagnetic waves - the electromagnetic spectrum
   2.3 Electromagnetic waves travel in space
   2.4 The atmosphere reflects, refracts, diffracts and absorbs electromagnetic waves
   2.5 UV radiation is absorbed by the ozone
   2.6 The ozone protects from UV radiation
3. The cell as basic structure and origin of living beings
   3.1 The cell structure
   3.2 Chemical components of the cell
   3.3 UV radiation affects the cells
   3.4 Diversity of living beings - phytoplankton and zooplankton
   3.5 UV radiation affects the different ecosystems
   3.6 Living beings adapt to changes in the environment
   3.7 Man activity changes the environment
   3.8 Man is responsible for preserving the environment

11th grade
1. Optical systems help man
   1.1 The microscope helps to study the cell
   1.2 Optical systems in the microscope
   1.3 Optical systems help to study the space
   1.4 Our eye, an optical system
   1.5 The eye suffers with UV radiation
   1.6 UV radiation intensity depends upon atmospheric conditions
   1.7 UV radiation changes together with ozone concentration in the atmosphere
2. Energy is necessary for chemical change
   2.1 Matter is made out of atoms
   2.2 Atoms have electric components
   2.3 Atoms emit waves
   2.4 Emission spectrum
   2.5 The study of light through its spectrum
   2.6 Energy participates in all chemical change
   2.7 UV radiation transports energy
   2.8 UV radiation provides energy for atmospheric reactions (O2 and O3)
3. The eye, as main information receptor for man and animals
   3.1 The eye structure
3.2 Vision and eye health
3.3 UV-B radiation damages the eye
3.4 How to protect the eye from UV-B radiation

12th grade
1. Carbon, an important element
   1.1 Carbon in chemical industry
   1.2 CFCs are made out of carbon
   1.3 CFCs are used in cold food preservation industry
   1.4 CFCs are used to isolate and save energy
   1.5 Cosmetic industry uses CFCs
   1.6 CFCs emission to the atmosphere
   1.7 CFCs reactions with the ozone
   1.8 CFCs destroy the ozone layer
2. Heredity and ADN
   2.1 ADN structure
   2.2 Genetic code
   2.3 Mutations and ADN
   2.4 UV radiation damages the ADN
   2.5 Skin health and UV radiation
   2.6 Cosmetic industry helps to protect the skin
   2.7 UV radiation in medicine

Closing Comments
It is important that Physics, Biology, and Chemistry teachers integrate among themselves. Students should see that each science has a role to play with respect to the ozone/UV-B radiation problem. Thus learning will turn meaningful. They will make different connections between the concepts studied in each course and the ozone problem will serve as a good organizer of knowledge.

As always, each teacher should emphasize the context which relates best to their actual school, students, and local environment conditions.

Editor's Comment:
It is important to remind readers that thematic teaching approaches, such as the Ozone theme, reorganize the content of science and ultimately help students find meaning and usefulness for this body of knowledge called science. In other words, we are not teaching Ozone, but are using themes and issues of interest to students to make the content of science and other areas come alive for students. If you wish to learn more about this extremely powerful teaching approach, consider searching the literature for: Science-Technology-Society (STS), Teaching in Context, Thematic Teaching, Inquiry-Based Teaching, Problem-Centered Learning or Constructivism.

Additional Ozone/UV-B Radiation Information
With respect to the ozone/UV-B radiation problem, reports indicate that Chile does not contribute significantly to atmospheric pollution through CFCs emission (see Table 3).

<table>
<thead>
<tr>
<th>Country</th>
<th>USA</th>
<th>E.C.</th>
<th>Japan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soviet Union</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Global Emission</td>
<td>35%</td>
<td>34%</td>
<td>14.2%</td>
</tr>
<tr>
<td></td>
<td>13.3%</td>
<td>2.5%</td>
<td>0.9%</td>
</tr>
</tbody>
</table>

Considering this, students should recognize the ozone problem as a serious one which, although not caused by Chile, affects the land and the population health and quality of life. They should understand the physical and chemical concepts related to the ozone decrease in the atmosphere, those related to the characteristics of UV radiation. They should also understand the biological aspects of damage caused by UV radiation to living beings.

Students should also be made conscious of the effort done by national industries for reducing emission and use of CFCs, although knowing that their impact upon the global atmospheric pollution is very small. Thus, they will recognise how scientific development and technological progress must collaborate to maintain the quality of life. Perhaps the above knowledge will attract them to science and to the choice of science as a professional alternative.

The curriculum, although taking into account the understanding of technological progress, should place more emphasis on the knowledge of sources of
danger and of ways for health protection. Curriculum in other countries should place the emphasis on global atmospheric damage and on the need of attitudinal changes, integrating social and public spheres, and understanding of scientific and technological development and their consequences.

References


Amedien, P. La controversia del ozono. Mundo Científico, 79(8), 442-454.


ASTRONOMY ACTIVITY AND RESOURCE NOTEBOOK PUBLISHED

The Universe at Your Fingertips, an 813-page astronomy activity and resource notebook for teachers in grades 3-12 (and astronomers who work with them), has just been published by the Astronomical Society of the Pacific. The loose-leaf collection includes 90 hands-on activities, dozens of annotated resource listings, featuring reading material by topic for students and teachers, and audio visual aids, computer software, and organizations that assist teachers, as well as a catalog of national astronomy education projects. In addition, the notebook contains articles on student learning, astronomy basics, and fitting astronomy into the science curriculum at various levels.

The Universe at Your Fingertips is $24.95 plus $6.00 for shipping and handling to U.S. addresses. California residents please add sales tax. Send orders to Astronomical Society of the Pacific, Notebook Order Dept., 390 Ashton Avenue, San Francisco, CA 94112; phone 1-800-335-2624.
A DISCUSSION LIST IN A SCIENCE METHODS COURSE

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An electronic discussion list has been used for two academic years by students who enrolled each semester in an elementary science methods course. Many students subscribed to the list and posted numerous messages during Spring 1995. This paper reports what students who subscribed to the list had to say about their experiences with the list. Some of the many messages which were posted on the list during Spring 1995 are also excerpted and reproduced in this paper.

Introduction

A recommendation made by the National Science Teachers Association (NSTA) is that science teacher preparation programs should provide preservice elementary science teachers “with experiences, materials, and skills which will enable them,” when they become classroom teachers, to “use electronic educational technology in teaching science” (NSTA, 1992-93, pp. 192-193). Incorporating an electronic discussion list into science methods courses which preservice teachers enroll in, is a good way to implement this recommendation.

Teachers of the future will have many opportunities to subscribe to electronic discussion lists and communicate with other teachers across the United States and the world. However, unless preservice teachers are provided adequate and appropriate experiences with discussion lists, they may not feel comfortable enough or knowledgeable enough to join and use discussion lists when they start teaching. This was one of the reasons why an electronic discussion list was established for use by students enrolled in an elementary science methods course.

What Are Discussion Lists?

A list is quite simply a list of electronic mail addresses. When someone wishes to subscribe to a list, he or she sends a message to the appropriate address with the request that his or her electronic mail address be added to the list of addresses. Once a person has successfully subscribed to a list, he or she will then start receiving copies of all the messages which are sent to the list.

A person who has subscribed to a list can also send messages to the list. These messages, like the messages sent by other subscribers, will be automatically copied and distributed to all the people who have subscribed to the list. In this sense, a list is an automatic mail distribution system.

Since many people use lists to share information and resources, and to exchange, argue, and “discuss” ideas on various topics of mutual interest, lists are also commonly referred to as “discussion lists.” Since these discussions are held electronically, these lists can also be called “electronic discussion lists.”

A Discussion List in a Science Methods Course

An electronic discussion list was established in Fall 1993. All students who enrolled in the science methods course were given the option of choosing, from a list consisting of a number of assignments, the assignments which they wished to complete in order to earn their grades in the course. Subscribing to the list and participating in discussions on the list was one of the assignments which students could choose. Since Fall 1993, many students have chosen to subscribe to the list and have posted hundreds of messages.

Students have used the list in many ways during the first two years of its operation. They have used it to:

• share ideas for science activities
• follow up on classroom activities
• share information about resources
• submit assignments
• ask questions and get answers
• answer instructor’s questions
• share their internship experiences with each other
• seek and receive ideas for use in the classroom
• provide feedback regarding course assignments
• provide feedback about the discussion list itself.

Sample Messages
During Spring 1995 semester, students were requested to answer the question “What are the qualities of a good science teacher?” The following are excerpts from some of the responses to the question which were posted:
• “A good science teacher must make science fun for the students, while at the same time providing them with the necessary information they need to learn the concepts.”
• “Also, enthusiasm for the subject is vital, as is an understanding of how science relates to so many areas of life and learning.”
• “. . . a science teacher needs to give the students lots of opportunities to discover things about the world around them. Hands on activities are a must.”
• “A good science teacher welcomes questions and does not discourage answers to questions. Flexibility is another quality that I think is important to have as a science teacher.”
• “A good science teacher needs to be willing to try new ideas and experiences.”
• “They should have current knowledge of science teaching methods and research. They should be willing to let students explore and discover.”

Students’ Reactions to the List
Also during the Spring semester, students were asked to answer the question “What will you tell someone if he or she asks you to describe your experiences with this list server?” All the students who took the time to respond to the question considered their experiences with the list to be beneficial. The responses posted by some of the students are excerpted and reproduced below:
• “The experience with the list was very inspiring and I have gained much from the personal input from everyone.”
• “Also, the list is a great place to share ideas and to learn about other’s experiences. I learned that I was not the only one who was frustrated by certain things or excited about certain things—my fellow students told me through E-mail about their experiences and I could compare them with mine.”
• “I like the list program but have not had the time to really enjoy it.”

• “I would strongly encourage students to take part in the list. You get plenty of encouragement and feedback on how internships are going. Not to mention all the original lesson plans you get access to! Plus, it helps many students who have not really worked with a computer to get familiar with it.”
• “I have enjoyed the communication with my “fellow” students through the list. I jot down ideas, book names, etc., for future reference. It’s been interesting to read about other people’s experiences in their field work.”

Conclusion
Students do benefit in many ways when discussion lists are incorporated into courses. As electronic communication grows in availability worldwide, it is a good idea to provide future elementary school teachers the experience of discussing ideas and exchanging information with their peers.

References

Please Note: The editor would like to remind our member organizations and individual readers that all articles in Science Education International are available for reprint in your own journals. All copyrights are extended to members. This is a wonderful opportunity. Please consider starting an international section for your journal and use our fine articles to expand global awareness. All we ask is that you give credit to the author and the ICASE Journal.
AN ALTERNATIVE FOR SCIENTIFIC FORMATION

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Introduction

Our current educational system tries to develop scientists through courses where students are basically taught to solve problems that are often unfamiliar and therefore irrelevant. The scientific attitude is buried under mountains of papers describing experiments, procedures, guidelines, etc. Nothing could be further from what science really is. Although the scientific attitude is really an attitude toward life and is present everywhere, it is in the laboratory, which is specially designed for research, where an activity like chemistry finds the best environment for its development. We set up a program, oriented toward the acquisition of knowledge where the young student can participate in a unique process: to learn how scientific research is done. Research, like any other activity, is learned by doing. With this principle in mind, we started a program that directly acquainted young students with the research presently being done in our Applied Experimental Chemistry Laboratory of the FES-Cuautitlán which is a separate campus of the Universidad Nacional Autonoma de Mexico (U.N.A.M.).

Our program goals are clear: to develop scientists through scientific research.
H. M. Cartwright (1980) and R. A. Bailey (1981) were some of the first to describe the results of integrated laboratories. Taking into account their findings and our own experiences, we offer the following recommendations for making an undergraduate research program successful:
1. Encourage student participation and initiative.
2. Stimulate the student to establish his or her own goals and the ways to achieve them.
3. Present complex problems in an integrated manner, encouraging the students to exercise their inventive and reflective capacities for solving problems.
4. Maintain scientific curiosity and a research spirit.

Implementation of the Program

In most chemistry programs, students usually do not begin research until the end of their studies (after the ninth semester). Our students dedicate more and more time to their research projects from the seventh semester on.

Our program invites students to do research, not to fulfill requirements. Because of the nature of their work many students spend long periods of time on their research projects, often years. Inevitably their daily work produces the undergraduate thesis and the social service required in Mexico to obtain a degree.

In our program neither a tight schedule nor a minimum amount of work hours is required. The students choose the amount of the time they want to dedicate to the project. Access to the lab, and equipment, is allowed all day long.

Frequently, working in a chemistry lab requires a minimum amount of work hours, for example, the time to assemble the equipment, carry out the reaction, separate certain products, and put the equipment back in place. In these cases, it is the student who decides when he or she will have enough time to carry out the experiment. A surprising result is that the students decide to spend considerable vacation time working on their projects. In fact, the spring break is the most productive period in our lab.

For a student to agree to spend many hours on his or her research project, it must be, at least, interesting, appealing, and important to him or her. At the same time, the suggested project must be feasible from the advisor’s point of view.

Four faculty members attend this program and the students are divided in small study groups. Students have choice in selecting an individual part from the main research project according to the cooperative group theory.

It is important to describe the research process in detail. Key points to be registered include: objective, experimental methodology, collected data, graphical representation of results and bibliography.
To carry out the main research as a group, it is necessary to study various subjects of different complexity. The newer students in the group start out with assignments that are relatively simple, but we consider them fundamental for the overall development of the research project.

The resulting projects are of high quality and offer importance from a scientific point of view. Sometimes a project that seems simple on paper turns out not to be so in the laboratory. The situation is not pleasant, but the students go to the lab to do research, not to get a good grade or to pass an exam, therefore it is not a depressing failure. On the contrary, these are valuable opportunities not only to go over the chemistry involved and come up with an explanation of the facts, but also to discuss the processes of science including the establishment of a hypothesis, the significance of negative evidence, and the role of experimentation in science.

The student lives the scientific method. Nevertheless, in some cases, changing the research focus is unavoidable, but nothing is lost and much has been learned.

As a result of structuring a research group as described, the communication level between its members is very high. During the weekly seminar where different techniques, procedures, the use of equipment and specific safety precautions are reviewed, newer students may discuss doubts or problems with their contemporaries, more advanced students or supervisors. They are all equally interested in what these students are doing and whatever advances develop or obstacles appear, because much of the group's future work depends on their results. It is hard to establish clearly what it is that motivates the student to commit himself or herself so seriously to a research project. No doubt it is a mixture of circumstances that are different for each person.

Many of the students that worked with us while completing their studies decided to continue with graduates studies. A total of 204 students have been enrolled in this program of which 30% have obtained a Master’s degree or Ph.D. degree. This reflects their individual commitments to scientific work.

We also think it proves, as we expected, the possibility of forming scientists by getting young students excited about research. Our students have participated in research seminars, presentations at national and at international chemistry congresses, and their results have been published or accepted in national and international scientific journals.

The richness of this experience is invaluable. All the papers are the result of teamwork. The students and advisors are directly involved, but we insist that the oral presentation should be done by the student, no matter how advanced they are in their major field. This is a useful practice because, among other reasons, the students get into the habit of presenting their work each time with more clarity, order, and even elegance. At the end they are convinced that their research is not completed until they have discussed it and have motivated their colleagues with their findings.

Something similar happens with papers for publication. In general, it is the student who has all the information and who, along with his or her advisor, prepares the manuscript with its tables, drawings, etc. They know that in these cases the examination of their work will be more gratifying. At F.E.S.-Cuautitlan our experience with this program has been positive. The laboratory does indeed connect and unify the chemistry curriculum.

Sample project topics include: Organic Chemistry, Food Chemistry, Polymer Synthesis, Physical Chemistry, Natural Products, Analytical Chemistry and Electrochemical Analyses.

Some comments that the students have given about the program are:

"With the purpose of solving real problems, the integration of different areas of chemistry is necessary".

"We learned to approach chemistry problems solving in a mature and independent way".

"We have used a new approach to chemistry work bases on research and independent work".

References

Science Teacher Education and Leadership

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This section focuses on the education of science teachers, and aims to communicate ideas and strategies which will assist science teacher educators to enhance and enrich their programs.

HOW DO YOU KNOW THAT: AN EPISTEMOLOGICAL CHALLENGE?
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Activities for Students

In working with science teachers from a wide range of countries—India, Belize, Indonesia, Pakistan, Nigeria—we have had to think carefully about:
- how we can help students learn science;
- what epistemological justifications there might be for scientific knowledge;
- what activities students might carry out to create epistemological justification.

We have come to address these questions more through our work with groups of teachers from overseas than from our interaction with UK science teachers. The reason for this is that we have worked with teachers who are keen to do more practical work with their students but who feel themselves frustrated by the usual litany of lack of equipment, chemicals and glassware, no technical support, textbooks that concentrate on facts, examinations that test recall and old fashioned syllabuses that pay little or no attention to the processes of science. We have therefore been trying to formulate alternatives that address the epistemological question of, “How do you know that?”.

In attempting to provide teachers with alternative strategies we have devised a generic approach that makes use of worksheets focusing in turn on each of the processes of science (Monk, Fairbrother and Dillon 1993). We have presented the processes of science as providing a framework for developing activities for students. So we encourage our science teachers in our short courses to think more carefully about:
- observing patterns in the real world
- making hypotheses
- designing experiments, surveys or data searches
- manipulating apparatus
- taking readings
- recording data

- transforming data and finding patterns in data
- building theories
- communicating ideas.

Then we point out that information comes in one of a limited number of forms,
- diagrams, photographs and pictures
- words in text
- tables of data
- graphs
- algebraic formulations.

Science teachers in our short courses spend time constructing activities for students that involve the students changing data given in one form, into another form, whilst engaging in one of the processes of science. The science teachers put together a package of these activities focused on one particular topic, e.g. the photo-electric effect, electrode potentials or gas exchange in humans, etc. The finished product should provide students with activities where they translate information whilst using the processes of science to develop an epistemological justification for the standard predictions that modern scientists make about natural phenomena. We try to create activities that take the students from a position of not knowing, to a position of both knowing what and knowing why. We try to hand them the opportunity to say how they know what they know.

Typically:
- a first sheet might show a flash-photograph of a falling ball. In groups, students can be asked to interpret such photographs and discuss their interpretations. Then representatives from groups can be called upon to explain their group’s ideas on what is happening and, more importantly from the point of view of turning empiricism into science, why they think it is happening.
• a second sheet might give a written description of some apparatus and the students are asked to draw the apparatus and then discuss their diagrams. A class display of diagrams can be used to preface a whole class discussion on what the definitive version might be and how it might be used.

• a third sheet may be rather sparse in simply asking students to design an experiment to test an hypothesis previously discussed by the whole class. Help and guidance can be given in getting the groups of students to be systematic in thinking about variables, controls, estimates of effects, suitable equipment, step-by-step procedures, and what confirming or falsifying results might look like.

• a fourth sheet might show some recorded trace of the movement of a falling ball alongside a standard rule. Students are asked to take readings from the sheet and to tabulate the data for themselves. A display of different tabulations can lead to a whole class discussion of the advantages and disadvantages of different tabulations.

• a fifth sheet can display data already tabulated. The students are required to find patterns in the data by transforming the data and analyzing the patterns. They would be encouraged to draw graphs to illustrate their results.

• next, the students might be presented with a graph or set of graphs and asked to write out in their own words what can be "read" from the graph. Students can be asked to decide on a group response which can then be used to formulate a whole class description.

• to take this pencil and paper activity beyond empiricism it is necessary to ask students to devise some theory that explains why the pattern they have deduced is as it is. This takes us back to the first sheet and questions about what is happening and why is it happening.

Working with Teachers

This brief outline example shows how part of our task, as teacher trainers, is to get the science teachers to take on board a pedagogy appropriate for use with these rather different materials for students. We endorse group work. We want science teachers to use the materials they have produced with students working in small groups, say four to a group. With a class of sixty students it is possible to run 15 groups of four. It is necessary to show teachers how to organize groups of students in a class. All too often, without explicit direction, our science teachers have four people in a line as a discussion group. When we see this we get the whole group of teachers to think about the management issues of grouping students in classes with a variety of furniture arrangements and different ways of seating. Usually we can do this with a great deal of good humor.

Each group works on the tasks on the sheet and then the teacher calls the group to order and collects feedback from the groups. The mistake that beginners make is to go through all 15 groups in turn. This is tedious beyond belief. We advise teachers to take feedback from two groups, three at the most, and then to open up the discussion for general comments. Good teachers finish each section of work with a general summary before starting on the next task.

Recently we have been working with groups of teachers from Korea. The issue for them is not one of doing practical work. Generally Korean schools are well equipped and they have enough for all their students. Rather, we find the teachers to be wedded to a strong teacher-centered pedagogy. We use this worksheet approach to try to pry them away from their blackboards and to hand control of students' learning over to the students working in small groups. They resist our efforts by commenting that our methods will:

(a) take too long;
(b) not be acceptable to students themselves;
(c) not be suitable for their syllabuses.

We counter with the arguments that:

(a) students speed up when they are familiar with the pedagogic strategy and that their learning is more effective in being active rather than passive learning;

(b) students are surprisingly enthusiastic about working this way but, like all things, doing only this will lead to boredom (variety is important);

(c) the method is more flexible than they think if they know their science.

Some of our science teachers find the materials production itself a hard task. There are several interesting things that can go wrong. Sometimes the science teachers try to use the activities as tests. That is, the students cannot reasonably be asked to do anything for which they are not handed the necessary information in the activity. Teachers who start on the production of these materials often create questions that are recall questions rather than processing tasks. Sometimes we have to go through each of the activities in turn and help the teachers to pull out all the recall and replace it with hypothesizing, designing, transforming, pattern finding and theory building activities.

Some science teachers do not actually know how or why modern scientists think what they do. This is a deep seated systemic problem that has to do with the way many textbooks, examinations and syllabi focus on the knowledge that is the product of science
rather than the processes of science. So, for instance, how do we know that DNA has a helical structure? How do we know that the atom has a nucleus? How do we know that alkanes are saturated? After working with us, a few of our science teachers spend a good deal of time brushing up on their own scientific knowledge and finding out, sometimes for the first time, why scientists think what they do.

A third problem has to do with layout and design. It is curious that teachers who come from countries that have flourishing traditions of graphic art and design often produce the most appalling products in terms of layout and design. Here the daily grind of coping with limited resources, such as poor chalkboards and very limited paper stocks, reduces the horizons beyond which the teachers look for alternatives. We try to get them to produce bold, clear, clean, graphics and text. We encourage good draughtsmanship. We actively press them to "spread their wings" across the page rather than cramming their work down into small overcrowded spaces. When they do take this on, and we must say the biologists generally have a head start, they can produce the most wonderful pages that make you want to get going on the activities straightaway. We expect them to carry the products back into their classrooms and motivate their own students with the same graphic skills.

The worksheets that focus on the processes of science and ask students to translate information from one form to another can help students focus their attention on the small scale detail that contributes to science’s success. The stepwise approach of the worksheets can help students gain confidence in their evidence in order to make legitimate claims. This can be more challenging for our teachers than for their students. Teachers who devise and use their own worksheets gradually come to appreciate this approach.

In order to make accurate predictions, ones that other people will take seriously, it is necessary to have some way of generating predictions. How do scientists do this? They study the properties of the natural world as it now is and as it was. They have a methodology. That methodology is contained in a set of processes and the iteration between processes allows critics to complain that there is no single way of going about the task. Two well known texts questioning the very notion of a scientific method are Feyerabend’s, “Against method” (1975) and more recently Woolger’s, “Science: the very idea” (1988). The generic set of processes used in our worksheets introduce students to the notion that there is a method to science. The flexible use of the worksheets by science teachers allows them to stress different processes for different topics. This can help students appreciate that success in science comes, in part, from the flair of knowing which processes to use at which stage.

However, the defining features of the methodology are not to be found in a specific chain of procedural operations but rather in a set of underlying beliefs about the nature of the tasks scientists set themselves when they use these processes. Dixon (1989) makes the point that the scientific method is distinguished from the messianic-prophetich-shamanistic method more by its axiology than its actions. Most scientists subscribe to the belief that the world is explicable and not mysterious, that cause-and-effect operate through direct linkages, that evidence needs to be set in the context of its plausibility and that conclusions need to be made with caution. The last two often involve some care over stating exact conditions, taking pains over repeated measurements and being skilled enough to use statistical methods to estimate errors and probabilities. By isolating the processes in the worksheets teachers can ask students to stand back and inspect those processes for their internal dynamic. The meta-question is, “What are we doing here?”

Finding patterns is not enough for the study of the natural world to become science rather than for it to get stuck at empiricism. Scientists also need to
build models of how the world might be in order to come to understand how the world is. The ancient Egyptians and Babylonians were skilled observers of the heavens. But without a model of the heavens that was mechanical, rather than mythological, all the Egyptian empiricism in astronomy trickled into the sands of astrological mysticism. Darwin’s ideas on evolution were viewed skeptically by many of his negligently knowledgeable critics as much for his inability to describe any mechanism for the evolutionary process as for anything else. No mechanism, no model, no theory - no science. How do we raise this issue, if at all, with our students? How do we help students to build their mental models so they have some theoretical, as well as empirical, justification for what they claim to know? Teachers need to be aware of this issue in the nature of science. The worksheets created under our direction and generated by our generic model do not directly address this issue. Instead, we need time with our teachers, and, in turn, they need time with their students, to discuss what sort of thing science is and how it works.

It has taken the past twelve years for us to reach this point where we, ourselves, can articulate what it is we are trying to achieve. We have reached this position because we have had the great privilege of working with a large number of patient and dedicated science teachers. We salute them for having helped us to help them. Without them, we ourselves would not know what we now know.

References

CONCEPT MAPPING: A GHANAIAN SECONDARY SCHOOL STUDENT’S EXPERIENCE

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Concept mapping is often seen as a technique for evaluation of teaching programmes, assessing knowledge and understanding of a topic, and for examination purposes, etc. But concept mapping also can be used as a technique for teaching and learning of science.

The present action research was designed to find out how students reacted to concept mapping as a teaching/learning technique. Twenty-two form two senior secondary biology students were involved in the study. The class was divided into four groups. The groups were introduced to concept mapping by means of a common topic in Biology.

The concept of fern reproduction was generated by the class through a brainstorming session and then used to create concept maps. Each group had two attempts at concept mapping. Students were positive towards concept mapping as a teaching and learning technique.

Introduction
Sizmur (1994) described concept mapping as a simple but flexible activity that can be integrated in science as well as other curriculum areas. Concept mapping show relationships between areas of knowledge. Sizmur (1994) referred to concept mapping as reflection in action since it creates a more reflective, constructivist and hence less transmissive, learning environment.

Concept mapping is described by Adamczzyk et al. (1994) as a multipurpose and multi-level tool. In other words, it can be used for many educational programmes including evaluation of a learning unit after instruction, measurement of longer-term
retention, or cooperative learning. It also can be used at any level of the learning process, from primary to tertiary.

The framework of a concept map, according to Adamczyk et al. (1994) is defined by prime descriptors and linked by propositions. The prime descriptors are the key words or components of the topic to be studied. The propositions are statements, or phrases that describe the relationship between the concepts. These relational comments are linked to the lines connecting the concepts. The lines have arrows at the end to indicate the direction of the relationship between any two concepts.

White and Gunstone (1992) describe concept mapping as a means of eliciting the relationships each student perceives concerning a concept. Concept maps can quickly reveal a complex structure of ideas about sophisticated concepts.

These descriptions and definitions reveal a number of applications or uses of concept mapping some of which include:

i) organization and consolidation of the learners' knowledge base;
ii) measurement of longer-term knowledge retention;
iii) promotion of cooperative learning in class as students talk over ideas, identify problems and share knowledge;
iv) evaluation of whole teaching programmes; and
v) assessment of knowledge and understanding.

These uses of concept maps indicate different types of concept map. Five of these have been described by Adamczyk et al. (1994) namely, free range, object only, the 'link only', prepositional and the picture map. Each of these are briefly described below.

Free Range—The students are given the opportunity to demonstrate what they know. The teacher provides a list of prime descriptors, which may be defined by the teacher or provided by an initial brainstorming session with students.

Object only—The teacher provides the concepts and the students to supply the propositions and the direction of arrows.

Link only—The students are to supply descriptors only

Propositional—Descriptors and propositions are provided and the student is expected to choose appropriate connections in order to build the pre-defined concepts.

Picture map—The students work in groups and link pictures representing the prime descriptors either verbally or by various written or pictorial methods.

A number of concept mapping research studies have been carried out for various purposes. Roth and Roychoudhury (1993) reported that concept maps resulted in meaningful learning of science concepts. This meaningful learning is thought to arise from at least two concept mapping features. First, concept maps assist learners to become aware of and control the cognitive processes of the task. Second, they assist learners to develop more integrated conceptual frameworks. Jegede, Alaiyemola and Okebukola (1990) showed that besides higher achievement, concept mapping was also associated with reduced anxiety. In addition, Okebukola and Jegede (1988) found that students who collaborate in concept map construction "attain meaningful learning better than students working individually."

Concept maps are ideal for helping students to examine and reflect on knowledge. They also help students to become more reflective, thus emphasizing the constructive nature of learning (Beyerbach & Smith, 1990).

Sizmur (1994) experimented with concept mapping as a group activity to examine the critical sharing of knowledge and whether new understandings emerge.

The study involved two groups of fifth and sixth grade children. Both groups used concept mapping as a learning tool. The first group was engaged in constructing habitats and food chains. The second group considered the relationship between the process of photosynthesis in plants and respiration in animals. He gathered recordings of the children's discussion as they engaged in concept mapping tasks. These were transcribed and analyzed.

Sizmur (1994) concluded that concept mapping is a valuable discussion task. It introduces idea in a tentative manner which invites differing interpretations. It provides opportunities to see and deepen the level of students' understanding. New ideas emerge as children engage in discussions.

Trowbridge and Wandersee (1993) studied concept mapping in a college course on evolution. The study examined how concept mapping could be used as an integral instructional strategy for teaching evolution, assess the impact of concept mapping on students' study practices, and on students' understanding of course content. They found that students who made concept maps spent an average of 37% more study time on this college biology course than on their previous biology courses. They also felt that the use of "seed concepts," "micromapping," a standard concept map format, and a standard concept map checklist made the strategy easy for the instructor to implement and for the student to adopt.

Huang (1993) designed an experimental study to investigate a relationship between concept mapping and science achievement at the elementary school.
level. The study involved sixth grade Taiwanese children. The experimental group received instructions in concept mapping prior to the study. A content pretest was then administered to both experimental and control groups followed by regular course instruction for all students. The teachers gave the students a list of concepts covered during instruction before the end of the class period. The experimental groups were asked to form concept maps and the control groups were to simply define the concepts.

A post test was administered to the groups after the end of the course units. Based on data analysis, science achievement was higher for students who had learned how to make concept maps than those who completed concept definitions. The researchers concluded that concept mapping techniques may be an appropriate method for sixth grade students to learn science.

The literature reviewed gives evidence to support concept mapping as a teaching and learning technique. Group concept mapping creates a friendly environment that promotes cooperative-learning. The individual in the group shares his/her ideas with others and through dialogue and trading ideas, the learner reconstructs or rejects his/her own ideas about issues discussed.

The present action research study was designed to find out whether concept mapping could be a useful technique for teaching biology at the senior secondary school level in Ghana. Presently, biological concepts are often defined for students to memorize. Little or no effort is given to help students make connections between concepts or to form a unit whole.

**Methodology**

**Sample**

An intact class was used for the action research. Twenty-two biology students of University Practice Secondary School, near the University of Cape Coast, were involved in the research. The group consisted of equal number of female and male students. Biology is one of the elective science subjects at the senior secondary level. The class has studied diversity of organisms and general principles of reproduction in different groups of organisms. The group had never been engaged in concept mapping.

**Procedure**

The ‘free range’ concept mapping technique was used because it exposes more of the student’s understanding of the subject content and their prior knowledge of the topic. The group approach also provides a better environment for sharing of ideas among students.

The topic used for this study was fern reproduction. The students had been introduced to the topic while studying diversity of organisms.

The class was divided into four groups of at least five students. Each group chose a leader to coordinate the discussion and a secretary to write what the group agreed upon.

The class was introduced to concept mapping by the researcher. A familiar topic, Living Things, was used to facilitate students’ understanding of the concept mapping process.

The prime descriptors of the topic were generated through a brainstorming session with the students. These included sporophyte, gametophyte, antheridia, archegonia, antherozoids/sperms, egg/ovum, prothallus, sorus, spores, zygote and sporangia.

The groups were then instructed to arrange the concepts on a sheet of paper to form a concept map. Pencils were used in the exercise to ease changes when necessary. While the groups were engaged in the exercise the researcher moved around to observe and to offer help to groups having difficulties. The researcher also noted the learning activities being carried out by the groups. When all groups were satisfied with the map produced, each group’s secretary represented their concept map on the chalkboard. Each group then presented their concept map and the whole class discussed each map.

After the discussion two new concepts were introduced by the researcher for a second attempt at concept mapping. The new concepts, “haploid” and “diploid,” were explained to the class. The second attempt was to perfect the groups’ concept mapping ability. The groups again represented their concept maps on the chalkboard for further discussion.

A short questionnaire was administered to the students to find out their impressions of the new technique. Some of the questions were:

1. What was the attitude of your friend during the activity?
2. Will you want to do more of concept mapping? Why?
3. Compare concept mapping technique to the normal teaching you experience in your biology class. Which one do you prefer? Give reasons for your answer.

**Results and Discussion**

Figures 1a, 1b, 2a, and 2b are examples of concept maps constructed by two groups. The examples are presented for the purpose of illustrating the progress of the students through the activities. The concept maps labeled A were the first attempts
by the groups and the label B indicates the second
attempts by the groups.

The groups presented concept maps of similar
pattern. The maps had a cyclical nature with one or
two branched inter connections. The patterns are
similar to what is presented in their textbooks where
the life cycle of Ferns is discussed. The concepts
were arranged hierarchically by all groups. All
groups except group 4 used all the concepts/prime
descriptors generated during the brain storming
session in their first maps.

A number of anomalies were noticed in the first
maps. Some links did not show the direction of the
relationship between the concepts connected (Figure
1b). Only group 4 showed the directions of the
relationship between the concepts linked (Figure 1b).
Groups 2 and 5 registered five errors respectively
while group 3 registered one error.

Propositions to indicate the type of relationship
between some concept were not stated. Group 4 did
not provide propositions for any of the links on the
map (Figure 1a). The group had a problem agreeing
on propositions.

The general discussion that followed the first
attempt at concept mapping improved the concept
maps in the second attempt

All groups improved upon the links between
concepts regarding the direction of their relationship.
Groups used the appropriate proportions to show the
relation between linked concepts. However, some
groups had a problem using the appropriate words.
For instance, instead of the gametophyte develops
antheridia and archegonia the students substituted the
word develops with produce (Figure 2a).

The new concepts introduced during the second
attempt were used by all groups except group 4. The
groups that used the new concepts however used
them as descriptive words, e.g. haploid sperms,
diploid zygote (see Figure 2b).

The students were expected to use them to form
links between concepts or stages of the cycle which
share these characteristics. This would have
increased the net work of their maps. The inability
of the groups to use the concepts haploid and diploid,
was an indication of poor concept understanding.
The concepts were discussed in detail with the
students. The level of interaction is in agreement
with Sizmur (1994) who also found concept mapping
to be a discussion activator.

The individual ideas proposed by group
members generated a discussion that moved personal
knowledge, held by the individual, to public
knowledge. Each student had to reconstruct his/her
ideas in the light of the discussion.

There was a sense of competition among the
groups during the first presentations made by each
group. Although this could have destroyed the
friendly learning environment concept mappings
provides, it actually motivated the groups to work as
teams to perfect the second maps. Group members
maintained a friendly environment and active
participation throughout the activity.

The concept maps of the groups revealed the
students understanding of the topic. The
improvement of their second maps indicated that
learning took place during the presentation and
discussion of the first maps. Hence concept mapping
can be an effective tool for teaching and learning in
the classroom.

The students also stated a positive attitude
toward concept mapping. This is in agreement with
the findings by Trowbridge and Wandersee (1993) as
well as Huang (1993).

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**THE LIFE CYCLE OF FERNS**

- **Prothallus**
  - produces
  - Germinates into Sporangia

- **Gametophyte**
  - produces Antheridia
  - produces Archegonia

- **Sporangia** (fer plant)
  - develops into Sporophyte

**LIFE CYCLE OF FERNS**

- **Gametophyte**
  - Produces Sporophyte

- **Sporophyte**
  - Produces Spores
  - Spores burst to release Sporangia

- **Archegeonia**
  - Produces Egg

- **Sperm**
  - Fused to form Zygote

**Figure 1a.** First concept map of Group 2

**Figure 1b.** First concept map of Group 4
The students answers to the questionnaire after the activities confirmed the use of the concept mapping as a teaching and learning technique with one or two precautionary comments made by some of the students concerning its use as a sole learning tool. The students preferred concept mapping as a teaching technique to the normal teaching of concepts. The concept map presents at a glance, the main concepts of the topic and how they are related and the topic is seen as a whole instead of as set of disjointed concepts.

The students saw the discussions that followed the presentations as integral for learning. The discussion improved the students' understanding of the topic as they shared and learned new ideas from their friends.

They also found the process useful for review before examinations.

However they expressed a concern for the time necessary to use concept mapping and felt that it should not be the sole technique for teaching. They voice concern that the biology syllabus could not be completed and they would not be prepared adequately for the final examinations. They suggested that it could be used sparingly to generate or sustain the interests of the students and to improve their understanding of difficult topics.

Though the action research was carried out with a class not representative of Ghanaian Senior Secondary school Biology students, a number of valuable conclusions were reached.

Concept mapping can be used as a pre-instructional and post-instructional tool in biology. The first instance will inform the teacher the level of student understanding. This will enable him/her to better prepare the lesson to meet student needs. The second provides insight into how well the students learned the material and their ability to connect information.

References
INVESTING IN PROFESSIONAL DEVELOPMENT
SERVING THE INFORMAL SCIENCE EDUCATOR

Andrea V. Anderson

"Somehow the experience changes you and challenges you to grow outward as you search inward.", project participant

If you had $1,000 to pursue a professional growth experience, what would you do? Would you look for a course or a workshop that interests you? Most educators find there is an abundance of learning opportunities. Advertisements for workshops arrive weekly, covering virtually every discipline and every curricular or instructional approach. One can simply choose among the options.

But what if you are the person who typically gives the courses or workshops attended by others under the rubric of professional development? What does a professional development provider do for his or her own personal growth and development? Teachers are expected to continue their education; shouldn't teacher educators follow suit?

In university settings, which are home to most teacher educators, conducting and reviewing research, taking sabbaticals, or attending conferences continues the intellectual growth and development of the individual. When the teacher educator works in an informal learning setting, such as a science center, how is the challenge of continued professional growth answered?

This report describes the activities undertaken by 33 informal science educators who designed professional development opportunities for themselves and their colleagues. The findings from their individual reports submitted at the conclusion of the experience, permit a brief glimpse at outcomes from various investments in professional growth. They suggest the value of investing in staff development and the amazing financial leverage achieved by educators who must make the most of every dollar.

Creating Professional Growth Opportunities

As part of a grant to the Association of Science-Technology Centers (ASTC), the Carnegie Corporation of New York provided $30,000 for a Small Grants for Professional Development program for museum-based science educators. The overall goal of the Carnegie project was to "strengthen the capacity of science museums to support school science programs." The solicitation for the small grants required alignment with that goal, permitting individual educators to request support for personal growth experiences, or to fund programs for museum colleagues and teachers.

The guidelines described the types of professional development activities appropriate for funding including but not limited to the following:

- visits to observe teacher education programs or school-museum partnerships in action
- participation in programs sponsored by other museums
- staff exchanges between two or more museums
- participation in NSF-sponsored summer institutes, accredited teacher education programs, or other workshops to improve skills necessary for teacher education

The procedure for applying was simple: the educator needed to "make the case" for their participation in the chosen activities. In addition to giving their own educational and experiential background, and a brief description about programs they offer, they had to answer questions about what they wanted the funds for; when, where, how, and with whom they would undertake the proposed activities; how proposed activities would benefit the participant and his or her institution; and why particular experiences would be valuable. Each application had to be accompanied by a letter of commitment from the participant's institutional leader, a budget, and a timeline. The proposals were reviewed by a committee that made the final recommendations.

While the solicitation was open to all museum-based teacher educators, half of the funds were reserved for educators who had attended the ASTC...
Inquiry Institutes. This was a deliberate strategy, building on the momentum of the prior workshops, which encouraged museum educators to become change agents in the reform of science teaching and learning. At the heart of the current science education reform effort is inquiry learning and teaching. These reforms require practitioners to know how to inquire and to facilitate others in inquiry. Shifting from a traditional science pedagogy to an inquiry approach requires ongoing support as individuals transform their own practice. Thus, an iterative experience with inquiry, observation or collaboration with others in trying new instructional skills, and an outsider working with one’s colleagues, were deemed the most effective approaches.

Through two rounds of proposals ASTC gave 23 grants to 33 educators from 22 institutions. The types of institutions represented included natural history museums, zoos, botanical gardens, children’s museums, and science centers. Awards ranging from $500 to $3,000 were given to institutions varying in size and in geographical location. Awards were given to individuals, to teams of individuals, and in two cases to an institution representative who invited colleagues to participate.

Choosing An Approach

Site Visits

Three approaches characterize how the museum-educators designed their experiences. Most frequently, awardees used funds for site visits to other institutions. For some, the purpose of visiting other sites was to assess programs similar to those of the participant’s own institution. For example, a mutual exchange between a museum in Minnesota and one in Saskatchewan allowed two educators to compare existing school visit programs and approaches to exhibit development.

For others, the site visit was exploratory, serving to generate new program ideas for the participant’s home institution. One team noted their museum was about to participate in a State Systemic Initiative (SSI), a multi-year program of science education reform funded by the National Science Foundation. By visiting another museum already engaged in such a program, they hoped to understand the functional relationship between the museum and the SSI effort.

Not surprisingly, given the intentional support to ASTC Inquiry Institute graduates, the site visits were used as a follow-up experience with inquiry learning. Being able to observe the implementation of others’ efforts illuminated principles that were crucial for inquiry instruction. A participating team commented on the value of follow-up experiences in observing others teach through inquiry.

The ASTC Inquiry Institutes gave us an inspiring start, and the professional development grants provided support that significantly increased our ability to move in this direction.

We [learned] a most valuable lesson—the importance of being aware of individuals and creating a feeling of familiarity and safety as people embark on learning something really new.

Hosting a Workshop

Another option was to host a workshop at the awardee’s institution for museum colleagues, teachers in the community, and educators from other institutions, including universities and other informal science institutions. Although this option was used less frequently than the site visits, it permitted many more individuals to gain from one funded experience. Indeed, one of the objectives for the institutions choosing this approach was to create a larger community of like-minded individuals.

One institution requested funds for two day-long sessions for educators in museums in North Carolina, South Carolina, and Virginia. It was expressly designed for educators who typically can’t attend national conferences by virtue of their position within the institution. The sessions were aimed at “professionalizing the museum educators engaged in teacher education at informal science institutions.” Twenty-five educators from 11 institutions attended the first session, and, as one participant noted,

I thought it was interesting when [faculty] asked how many would be at the ASTC meeting and only 2 hands out of 25 went up—you are meeting a need for staff development. There’s certainly a benefit to doing this at an “away” site; it seems more like real professional development for these folks who are working their hearts out at their jobs, and one day makes it manageable logistically. I hope we are able to continue.

Sometimes participating as an individual in professional learning opportunities is insufficient to achieve desired institutional changes. One individual, feeling isolated following his prior professional development experience at the Inquiry Institute, needed to build a community of learners around the inquiry approach to science teaching and learning. He requested funds to bring the expertise to his institution and invited museum colleagues, teachers, and peers from other institutions to participate. His purpose was specific:

I realized that I was the only staff person from my museum who had the opportunity to
explore, discuss, and reflect upon the nature of inquiry. If inquiry was to catch on at the museum, then other staff members also needed to have a meaningful experience with this approach to science education.

Attending a Formal Program

In only two cases was the money used to attend a formal professional development program offered by non-museum educators. One science center in San Francisco, well known for its teacher education programs, wanted a learning experience that would take museum staff and their Teachers In Residence to a new level. In attending a symposium on action research, the team felt

what was important was finding a way to form a network, to share observations with others, and to encourage them to consider themselves fully empowered professionals, teachers influencing other teachers.

For this team it was necessary to seek expertise outside of the traditional realm of science education to attain the professional growth they desired.

As a next step in teacher development we wanted to offer the opportunities for these Lead Teachers to become involved in teacher research, reflecting on their own learning and their teaching of science.... We feel that it is important for these teachers to learn to reflect on and articulate their teaching capabilities, and to observe more closely how their children are learning.

Noting Outcomes

While many participants reported “it was a great experience” others went into depth about changes in thinking, changes in programs, and products created as a consequence of either visiting other sites, hosting or attending workshops. What seems most productive is suggesting the range of application made by professionals as a consequence of their own learning experience.

After visiting two institutions, a museum and a nature center, one educator developed a “Protocol for Reciprocal Professional Development Experiences,” suggestions aimed at helping host sites know better how to shape an effective visit experience. This Protocol document will be published by ASTC on the World Wide Web as a service for informal science educators.

One museum reconceived its service to teachers in the community and the museum’s role as a center for inquiry as a consequence of a site visit to the Workshop Center at City College in New York. A teacher center was designed, with teaching kits, a wide variety of inquiry materials, and scientific expertise available daily for district teachers who drop in or request specific support. The education center of the museum became a home for teachers—a type of teachers’ lounge away from the school, where conversation, exploration, and professional dialogue could flourish.

The museum expecting a successful grant for a State Systemic Initiative took its lessons learned and applied for a local systemic initiative grant from the National Science Foundation. This museum is now supporting every educator in three rural school districts in developing their own abilities to do inquiry science.

The San Francisco team piloted a Teacher Research Network. In addition to the museum’s staff, nine teachers attended our Teacher Research Network meetings [the first year]; seven returned [the second year] joined by four others. They met every two weeks, and discussed articles.

Findings

Multiple Strategies

Three different strategies define the type of professional development experience chosen by participants. While most grant recipients used the money to visit other sites, some used the funds to bring in an expert and thereby extend the reach to more museum staff. A small number of the grantees used money to attend a workshop or conference. What is intriguing is that informal science educators prefer to construct and control their own learning experience. Taking formal courses was the exception, not the rule, an approach that may reflect the informal educator’s predilection for learning and teaching in nontraditional ways.

Multiple Benefactors

Also striking was the recipients’ capacity to leverage the funds and extend the investment. While the money was given directly to either individuals or to a team of two or three, the influence of the funds extended to a much larger number. In measuring outcome, either the funds supported multiple people to participate in an experience, or it fostered the formation of networks, implementation of training programs, or creation of products to be shared among educators. In all cases the awardees found money or in-kind donations to match the original grant.

The Nature of the Benefits

The value of these experiences is more often felt than catalogued. Sometimes the educator can point directly to an outcome and say, “Therein is the
benefit.” More often, the change is dynamic, internal, and difficult to grasp. It encompasses reflection, catalyzing change and innovation, an appreciation of time, and connections. It is sometimes difficult to make the case that a program has been effective. However, the following quotes suggest the nature of the benefits derived from the Carnegie small grants.

Professional development opportunities, such as the one offered through ASTC, serve a role that is sometimes difficult to measure. The opportunity to stretch and use one’s imagination as a result of reflective time in a different museum setting is invaluable. One returns to the workplace energized and filled with excitement about the potential to grow.

Having the time to reflect on the work museum educators do was the single most identified benefit. A comment by one member sums up the feelings and thoughts of many.

It’s difficult to state strongly enough the value of conversations with other educators that the grants made possible. Sharing ideas with people from other institutions made for wonderful cross fertilization, and the special circumstances justified dedicating enough time to explore topics without hurrying and without necessarily following the most direct path to making decisions and getting things done.

This kind of rejuvenating opportunity is unusual in our sped-up times.

Museum educators said being validated as a professional was a significant benefit.

The grants presented an opportunity rare in museum culture: they validated the idea that collegial contact and conversation could be a significant and worthwhile way of working as well as a model of professional development, with real value for the institutions as well as for the individual employees.... it was not just by providing funds that the grants made our experiences happen, but also by helping us to imagine them as worthwhile and possible.

Having a first-hand experience, seeing programs and ideas within context, and gaining perspective was a benefit.

As we construct our understanding of these new tools and their applications, we are facilitated by observing how others are meeting these challenges...seeing things in context is of great value.

While not all the participants described the consequences of their experiences, those that did spoke of making changes in designing new programs, attempting new instructional strategies, creating new environments, initiating inquiry institutes, and networking with others. One grantee observed that the professional development experience “led beyond acknowledgment to commitment.” In fact, most participants launched a variety of new innovations at their home institutions.

Finally, many people commented on the value of networking, of meeting others in parallel positions, of sharing ideas, practices, and materials. A team from Philadelphia wrote,

A strong outcome of this trip was the especially strong sense that we had colleagues with whom we could share problems, questions, and ideas and that we really could learn from each other.

The challenge now facing us is to build on this model and create similar professional development opportunities worldwide. As we have seen in this project, a small investment can result in tremendous professional growth.

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THE LEARNING SUPERHIGHWAY

New World? New Worries?

3rd INTERNATIONAL INTERACTIVE MULTIMEDIA SYMPOSIUM

Perth, Western Australia
January 21 - 26, 1996

For registration forms and additional information, please contact:

PROMACO CONVENTIONS PTY LTD
PO Box 890, Canning Bridge
WESTERN AUSTRALIA 6153
Tel: +61 9 364 8311
Fax: +61 9 316 1453
Email: promaco@cleo.murdoch.edu.au
NSTA PROGRAM PROPOSAL
Global Summit on Science and Science Education
San Francisco, California, December 27-29, 1996

(PLEASE TYPE INFORMATION AS YOU WISH IT TO APPEAR IN CONVENTION PROGRAM)

PRESENTERS:
1. Name ___________________ 2. Name ___________________
   Dept. ___________________ Dept. ___________________
   Coll/Univ/Corp ___________ Coll/Univ/Corp ___________
   Work Address ____________ Work Address ____________
   City, State, Zip __________ City, State, Zip __________
   Phone: work ( ) Phone: work ( )
   home ( ) home ( )
   FAX: ( ) FAX: ( )
   E-mail: ________________ E-mail: ________________
   □ Additional presenters are listed on an attached sheet.

PRESIDER DATA: Complete only if you wish to name the presider for your presentation.
Name ___________________ Dept. ___________________ School/Inst. ___________________
Work Address ______________ City __________ State __________ Zip __________ Tel. ( )

SESSION DATA:
I. Session Title
   Brief Description (limit to 25 words)

II. Type of Session
   A. □ Hands-On Workshop
      A 60-min. presentation that actively engages everyone in the audience in a hands-on experience with materials. Work table setup.
   B. □ Demonstration □ (30 min.) □ (60 min.)
      A 30-min. or 60-min. presentation where presenter(s) demonstrate a series of experiments or a scientific phenomenon. Theater-style setup.
   C. □ Poster Session
      A 60-min. mini-exhibit of ideas displayed on corkboard(s) by one or more presenters. Flea market-style setup.
   D. □ Lecture/Discussion □ (20 min.) □ (30 min.)
      A 20-min. or 30-min. opportunity to share an innovative teaching idea or present the results of research. Theater-style setup. (Formerly called Contributed Paper.)
   E. □ Panel
      A 60-min. interactive session by two or more speakers on a topic of general or specific interest, including a question-and-answer period. Theater-style setup.
   Z. □ Other

As a reminder, a presentation that promotes a product in which the presenter has a financial interest (or is representing a company that has a financial interest) must be proposed as a commercial workshop. In order to propose a commercial workshop, the company must be exhibiting at the convention. For information, contact Paul Kuntzler, Director of Advertising and Exhibit Sales, NSTA, 1840 Wilson Blvd., Arlington, VA 22201-3000, (703) 312-9265.

(See reverse side for additional information)
III. Subject Area (Check only one for listing in Final Program)
A. ☐ Astronomy  B. ☐ Life Science  C. ☐ Chemistry  D. ☐ Computer Science  E. ☐ Elementary  F. ☐ Ecology/Environment

See the list of strands and topics on the backcover.

IV. Intended Audience
A. ☐ General  B. ☐ Minimal Math & Science Background  C. ☐ High Level Math & Science Background

V. AV Equipment Required
NSTA will provide one overhead with screen for all sessions. NSTA will also provide microphones for sessions scheduled in rooms seating 100 or more. Please note: Participants may request the equipment listed below if essential to the presentation. Please consider the necessity of this equipment. NSTA's rental expense has increased significantly.

A. ☐ Overhead (NSTA will provide)

One computer and/or VCR will be provided if necessary. (Check box below)

B. ☐ 1/2" VHS with 25" monitor
C. ☐ Macintosh (8 MB) (or equivalent model) with monitor
D. ☐ IBM or IBM-compatible 486 VGA computer with DOS (or equivalent model) with monitor
E. ☐ Slide Projector with screen

VI. How many participants do you wish to accommodate at your session?
(Room assignments based on meeting space availability)
A. ☐ 45-65  B. ☐ 66-99  C. ☐ 100 +

SAFETY (guidelines on following pages)

Identify any potential safety hazards associated with your presentation:

What precautions will be taken during the presentation to deal with these hazards and to inform the audience?

What safety equipment will be required?

I have read a copy of the "Minimum Safety Guidelines for NSTA Presenters and Workshop Leaders" and agree to comply with the guidelines during my presentation.

Signature ___________________________ Date ______________

YOU MUST SIGN THIS

VII. Abstract (150-200 words—Provide details of your session content and activities on an attached sheet)

RETURN THREE COPIES OF THIS PROPOSAL BY MARCH 1, 1996, TO:

Donna Fletcher, Conventions, National Science Teachers Association,
1840 Wilson Blvd, Arlington, VA 22201-3000, U.S.A.

34
NSTA MINIMUM SAFETY GUIDELINES
FOR PRESENTERS AND WORKSHOP LEADERS

PREAMBLE: The National Science Teachers Association, an organization of science education professionals dedicated to the stimulation, improvement, and coordination of science teaching and learning, supports scientific safety at all levels. Presenters, workshop leaders, contestants, and authors at NSTA-sponsored activities serve as role models for other science educators. As role models, these individuals must develop, encourage, and display good safety habits at all times. A good safety role model promotes positive safety in actions, words, behavior, and deeds. Science safety is an integral part of science education and serves as a preparation for life. Accordingly, NSTA encourages teachers to offer meaningful and safe science experiences both inside and outside the classroom. NSTA requires that all presentations, workshops, and related science education activities be conducted in accordance with recognized safety procedures and good common sense. The intent of the safety guidelines that follow is to promote safe science practices at all NSTA-sponsored activities.

ALL PRESENTERS AND WORKSHOP LEADERS MUST FOLLOW THE NSTA MINIMUM SAFETY GUIDELINES

THE FOLLOWING MAY NOT BE PART OF ANY PRESENTATION OR WORKSHOP AT AN NSTA CONFERENCE UNDER ANY CIRCUMSTANCES:

1. Parts of the body are not to be placed in danger, such as placing dry ice in the mouth or dipping hands or fingers into liquid nitrogen or molten lead. Demonstrations such as the following shall not be conducted: walking on broken glass or hot coals of fire with bare feet, passing an electric current through the body, and lying on a bed of nails and having a concrete block broken over the chest.
2. Live vertebrate animals may not be used in demonstrations or for experimental purposes. Such animals may be used only for observational purposes provided the animals have been lawfully acquired, are housed in proper containers, and are handled in a humane way following the NSTA’s “Guidelines for Responsible Use of Animals in the Classroom” (NSTA Position Statement).
3. Live ammunition, firearms, or acutely dangerous explosives, such as benzoyl peroxide, diethyl ether, perchloric acid, picric acid, and sodium azide, may not be used. Commercially available firecrackers and blasting caps shall never be employed.
4. Plants with poisonous oils (e.g., poison ivy), saps (e.g., oleander) or other plants known to be generally toxic to humans are not to be used. (Resource: Human Poisoning from Native and Cultivated Plants, by James W. Hardin & Jay M. Arena. The publisher is Duke University Press, Durham, NC 27708.)
5. Experiments or demonstrations with human blood/body fluids may not be conducted.
6. Radioactive powders, liquids, or solutions are not to be used in a nonlaboratory facility.

GUIDELINES FOR PREPARING YOUR PRESENTATION:

1. Practice all demonstrations or workshop procedures BEFORE presenting them to an audience or having participants try them.
2. Research and understand the properties, chemical reactions, and dangers involved in all demonstrations. Plan to use correct handling procedures for all biohazards used. Arrange to have a fire extinguisher available whenever the slightest possibility of fire exists.
3. Prepare a handout that gives participants detailed instructions about the procedures, safety precautions, hazards, and disposal methods for each demonstration.
4. Prepare photographs, slides, videotapes, and so on, that show safe science practices. When preparing these materials, safety goggles and equipment shall not be removed for aesthetic considerations.
5. In planning demonstrations and/or workshops, keep quantities of hazardous materials to a minimum. Use only those quantities that can be adequately handled by the available ventilation system. Do not carry out demonstrations that will result in the release of harmful quantities of noxious gases into the local air supply in the demonstration or other rooms. The following gases shall not be produced without using a fume hood: nitrogen dioxide, sulfur dioxide, and hydrogen sulfide. Volatile, toxic substances such as benzene, carbon tetrachloride, and formaldehyde shall not be used unless a fume hood is available.
6. Make sure your glassware and equipment are not broken or damaged. The use of chipped or cracked glassware shall be avoided. If glassware is to be heated, Pyrex™ or its equivalent shall be used.

7. Thoroughly check motor-driven discs that will be revolved at moderate or high speeds. Make sure the disc is sturdy, that it contains no parts that may come free, and that the safety nut is securely fastened.

8. Arrange to use a safety shield and/or eye protection for audience members and interpreters for any demonstration(s) in which projectiles are launched or when there is the slightest possibility of an unsafe explosion. Arrange for proper shielding and protection for demonstrations which involve radiation. Only low-level, radioactive sources shall be employed. Do not allow direct viewing of the sun, infrared, or ultraviolet sources.

9. Make sure any lasers to be used in demonstrations are helium-neon lasers with a maximum output power rating not exceeding 1.0 milliwatt. At all times, avoid direct propagation of the laser beam from the laser into the eye of an observer or from a reflected surface into the eye.

10. Secure pressurized gas cylinders by strapping or chaining them in place or by using proper supports, i.e., lecture bottles.

11. Obtain, in advance, the necessary state and/or local permits needed for the firing of model rockets. Activities involving the firing of rockets must be well planned and follow Federal Aviation Agency (FAA) regulations, state and local rules and regulations, and the National Association of Rocketry’s (NAR) Solid Propellant Model Rocketry Safety Code.

12. Arrange for appropriate waste containers and for the disposal of materials hazardous to the environment.

13. Plan to dress safely for your presentation or workshop.

14. If you have any questions concerning safety and your presentation, contact the NSTA Associate Executive Director of Conventions (703-243-7100).

**DURING THE PRESENTATION:**

1. Comply with all local fire and safety rules and regulations. Follow the “NSTA Minimum Safety Guidelines.”

2. Wear appropriate eye protection, an apron, and similar protective gear for all chemical demonstrations or when appropriate for other demonstrations. Provide eye protection, aprons, and safety equipment for participants who will be handling chemicals, hazardous substances, or working with flames.

3. Do not select “volunteers” from the audience. Assistants used in demonstrations shall be recruited and given the proper instructions beforehand.

4. Warn participants to cover their ears whenever a loud explosion is anticipated.

5. Use a safety shield for all demonstrations that involve the launching of projectiles, or whenever there is the slightest possibility that a container, its fragments, or its contents could be propelled with sufficient force to cause injury. Shield moving belts attached to motors. Use caution when motor-driven discs are revolved at moderate or high speeds. Shield or move participants to a safe distance from the plane of the rotating disc.

6. Follow proper procedures for working with pressurized gases.

7. Use appropriate gloves and shields when working with hazardous chemicals, cryogenic materials, hot materials, radioactive substances, vacuums, electromagnetic radiation, and when presenting animals for observation.

8. Do not taste or encourage participants to taste any nonfood substance. A food substance subjected to possible contamination or unsafe conditions shall never be tasted.

9. Note clearly at the beginning of the program the presence or production of allergenic materials such as “theater” smoke, lycopodium powder, or live animals.

10. Maintain clear egress during the demonstration or workshop.

11. Emphasize and demonstrate appropriate safety precautions throughout the presentation or workshop.

12. Distribute a handout that will give participants detailed instructions about the procedure, safety precautions, hazards, and disposal for each demonstration.

—Adopted by the NSTA Board of Directors, August, 1994

Science Education International, Vol. 6, No. 4 December 1995
Resources

VOICES OF EVOLUTION: A REVIEW

Duane Jeffery
Professor of Zoology
Brigham Young University, Salt Lake City, Utah

This one-of-a-kind publication belongs in every library dealing with science and science education. Born of the continually smoldering creationist controversy in the United States, it brings together 86 formal statements addressing creationism, evolution, and their proper roles in religion, science, education, and society at large. It summarizes the six most critical court cases on the issue, and gives extended excerpts from four of them.

The 86 statements include 40 from scientific organizations (e.g., the Academy of Science of the Royal Society of Canada, the American Anthropological Association, the American Association for the Advancement of Science, the American Institute of Biological Sciences, the National Academy of Sciences [U.S.], the Geological Society of America, and various state academies of science), and 15 from religious organizations (e.g., the American Jewish Congress, Center for Theology and the Natural Sciences, a number of major Protestant groups, and Pope John Paul II for Roman Catholicism). Eleven statements derive from civil liberties organizations (e.g., Americans for Religious Liberty, Institute for First Amendment Studies, and People for the American Way). The remaining 20 come from 17 educational organizations such as the American Association of Physics Teachers, the Biological Sciences Curriculum Study, the National Association of Biology Teachers, and various state teachers' groups.

Beyond just stating formal positions, this collection supplies some of the most sensitive and sophisticated analyses available on these critical topics. The legal summaries will be especially useful for teachers and school boards facing pressure from creationist groups and individuals. Highly recommended for all persons in these fields, and a must for libraries.


Membership in the National Center for Science Education, which publishes Voices, is $25.00 per year, and that includes a subscription to the journal: Creation/Evolution. Voices, itself, sells for $10.00 to members of NCSE, $12.00 otherwise (includes postage).

1996 CEFIC SCIENCE EDUCATION AWARD

This annual Award, created by the European Chemical Industry Council, CEFIC, and it's National Federation Members, will recognise excellence in science education achieved by a teacher and a class of pupils—aged 10 to 17 years.

The Award comprises three prizes for the winning team:

- A one-week, all expenses paid, trip to another European country.
- 5.000 ECU for the purchase of scientific or teaching equipment for the school of the winning team, and
- 1.000 ECU plus a "Diploma of Excellence" for the teacher.

In addition, prizes will be awarded to other particularly meritorious entries.

Entries should be sent to your National Chemical Industry Federation by April 16, 1996. An independent international jury will select one team comprising a teacher and a class of pupils who by their innovative project have demonstrated a more effective and attractive way of teaching Chemistry or Science in general. The Award will be presented on the occasion of the CEFIC General Assembly in Amsterdam June 14, 1996.

The rules of operation and further information may be obtained from:

Science and Technology Department
Avenue E. Van Nieuwenhuysen, 4 Box 1
B - 1160 Brussels
Phone: +32 2 676 72 07
Fax: +32 2 676 73 30

Science Education International, Vol. 6, No. 4 December 1995
Calendar
1996-1997

Industry-Education (ELF Sponsored)
Location: Paris

January 4-6, 1996
ASE Annual Meeting
Location: University of Reading
Contact: Iris Sinfield
Association for Science Education
College Lane
Hatfield
Herts AL10 9AA
UK
Fax: +44 1707 266 532

Although the meeting officially starts on January 4th, there will be a special International Seminar organised jointly by ASE and ICASE on Wednesday, January 3rd. The subject will be "Continuing professional development of the science teacher" and contributors are very much welcomed. There will be accommodations available on Tuesday, January 2nd, for those attending. As well as the British Council symposium and an international reception, there will be hundreds of sessions to interest and inspire, whatever the level—primary, secondary, tertiary, or higher education.

January 5-10, 1996
GASAT 8 International Conference
Location: Ahmedabad, Gujarat, India
Contact: Jayshree A Mehta
Conference Chair/Convenor
GASAT 8 Secretariat
SATWAC Foundation
A1/22, Amarpali, Sukhipura,
New Shardamandir Road,
Paldi, Ahmedabad-380 007, INDIA
Tel: 91 79 428991, Fax: 91 79 416941

January 8-11, 1996
JISTEC '96—The Second Jerusalem International Science and Technology Education Conference
Location: Jerusalem, Israel
Theme: Technology Education for a Changing Future—Theory, Policy and Practice
Contact: Dr. Arley Tamir, Conference Chairman, or The Conference Secretariat
POB 57005, Tel Aviv 61570, Israel
Fax: +972-3-6133341

The conference expects to provide a forum for discussion on technology education, an opportunity for exchange of ideas and for reporting on achievements by experts, researchers and developers from both developed and developing countries. It is anticipated it will bring together education policy decision makers, educators, and other professionals from institutions of higher education, teacher training institutes, schools, educational authorities, etc.

January 21-26, 1996
3rd International Interactive Multimedia Symposium
Location: Perth Western Australia
Contact: Promaco Conventions Pty Ltd
ACN 008 784 585
PO Box 890, Canning Bridge, Western Australia 6153
Tel: (61) (9) 316-1453
e-mail: promaco@cleo.murdoch.edu.au

February 7-9, 1996
International Consortium for Research in Science and Mathematics Education (ICRSME) 6th Consultation
Location: Belize City, Belize
Central America
Contact: Dr. Arthur L. White or Dr. Donna F. Berlin
The National Center for Science Teaching and Learning (NCSTL)
Room 100
Ohio State University
1929 Kenny Road
Columbus, OH 43210-1015 USA
Tel: (614) 292-3339, Fax: (614) 292-1595

March 7-8, 1996
16th Triennial LMFK Nordic Congress for Math and Science Teachers and the UNESCO-INISTE Conference (being held in parallel)
Location: Linköping University, Sweden
Theme: Educating for the Future—Energy Environment Communication

March 28-31, 1996
NSTA National Conference
Location: St. Louis, MO, USA

March 28-April 5, 1996
EDUTOURS, Inc.
Location: United States
Contact: Mr. Dennis Chisman, Knapp Hill, South Harting, Petersfield, GU 31 5LR, UK.
The International Council of Associations for Science Education (ICASE) in conjunction with ICASE member associations is offering a Science Education and scenic tour in the United States.

April 1-4, 1996
XVIII International Meeting on Communication, Education and Scientific and Technological Literacy
Location: Centre Jean Franco, Chamonix, France
(This meeting will be in French.)
Theme: Sciences, Techniques and Public Understanding
Contact: Daniel Raichvarg
G.H.D.S.O.—L.I.R.E.S.T. Bat 307
Universite Paris-Sud
F-91405 Orsay Cedex, France

This meeting will explore the various modes of promoting scientific and technological literacy—the media, museums, schools, associations, etc., and consider the developments, successes, limitations and concerns that have arisen. The meeting will include lectures, presentation of research findings and discussion sessions.

May 28-31, 1996
14th Dortmund Summer Symposium
Theme: Educational Research in Chemistry and Physics Education
Contact: Dr. Hans-Jürgen Schmidt
University of Dortmund, Dept. of Chemistry
Otto-Hahn-Str. 6
43221 Dortmund, Germany

The main aim of this conference is to discuss the methodology of empirical research in this field.

June 14-18, 1996
First World Congress on Science Centres
Location: Finland
Contact: Ms. Helena von Troil, Secretary General
Heureka, The Finnish Science Centre
PO Box 166
FIN-01301 Vantaa, Finland
Tel: +358 0 85799
Fax: +358 0 873 4142

The Association of Science-Technology Centres (ASTC) and the European Collaborative for Science, Industry and Technology Exhibitions (ECSITE) invite science centre professionals from all over the world to the FIRST SCIENCE CENTRE WORLD CONGRESS to be held at Heureka the Finnish Science Centre in Vantaa (Helsinki), Finland. The congress will give opportunities to learn and share the experience of colleagues from all over the world.

June 14, 1996
1996 CEFIC Science Education Award
Location: Amsterdam
Contact: Science and Technology Department
Avenue E Van Nieuwenhuyse, 4 Box 1
B-1160 Brussels; Tel: +32 2 676 72 07
Fax: +32 2 676 73 30

This annual award, created by the European Chemical Industry Council, CEFIC and its National Federation Members will recognise excellence in science education achieved by a teacher and a class of pupils aged 10 to 17 years.

July 14-19, 1996
14th International Conference on Chemical Education
Location: Brisbane, Australia
Contact: The ICCE Conference Secretariat
(Sally Brown), Continuing Professional Education,
The University of Queensland 4072 Australia
Tel: (07) 365 6360 Intl: +61 7 365 6360
Fax: (07) 365 7099 Intl: +61 7 365 7099
E-mail: chemed96@ceu.uq.oz.au

The 14th ICCE will be held in Brisbane from July 14-19, 1996. It is only the second time this conference has been held in the southern hemisphere. The biennial conference brings together chemistry teachers, chemists and science educators from school, industry and university settings to share ideas and learn from one another about innovation in teaching and learning and the discipline of chemistry. The theme, Chemistry: Expanding the Boundaries, acknowledges the centrality of chemistry through its expanding relationship with many facets of science and everyday life. Conference participants will be challenged to develop this theme with the view of enhancing our understanding of the important relationships which chemistry forms with the new frontiers of human endeavour. Implications for chemical education beyond 2000 which give a “science for all” perspective will be encouraged.

July 22-26, 1996
EDINBURGH '96: The Fourth International Conference on School and Popular Meteorological and Oceanographic Education
Theme: Roles of meteorology and oceanography in science education
Location: Edinburgh
Contact: Mr. J. M. Walker, Dept. of Maritime Studies
PO Box 907, Cardiff CF1 3YP, UK
Tel: +44-1222-874271, ext. 6754
Fax: +44-1222-874301;
e-mail: walkerjm@cardiff.ac.uk

**July 30-August3, 1996**

16th Nordic LMFK Conference  
Location: Linkoping, Sweden  
Theme: Baltic Sea Project and the INISTE Network  
Contact: Lisbeth Ekstrom  
LMFK-Kongressen 1996  
Gia Ledbergsvagen 6  
S 58320 Linkoping  
Sweden

**August 4-8, 1996**

14th Bicentennial Conference on Chemical Education  
Location: Clemson University, Clemson, SC  
Contact: DeWitt Stone, BCCE General Chair, 206  
Sikes Hall, Clemson, SC 29634-5170  
Fax: (803) 656-1515; e-mail: bcce@clemson.edu  
WWW address: “http://tigerche.d.clemson.edu”

The Planning Committee has selected “Chemistry: The Challenge of Change” as the conference theme. The uses of computers and multimedia technology in chemistry teaching will be a particular focus of this conference. Another focus will be topics such as biotechnology, polymers, textiles, advanced materials, and environmental science—fields in which chemistry overlaps with the interests of other disciplines.

**August 23-28, 1996**

9th Annual Visitor Studies Conference  
Location: Estes Park, Colorado  
Theme: “Listening Outside”  
Contact: Marcella Wells, Conference Coordinator  
Colorado State University, Fort Collins, CO 80523  
Tel: (970) 491-5358; Fax: (970) 491-2255  
e-mail: marcella@picea.cnrr.colostate.edu OR  
Margie Marino, Workshop Coordinator  
Denver Museum of Natural History  
2001 Colorado Blvd.  
Tel: (303) 370-8342; Fax: (303) 331-6492

The intent of this conference is to foster a network among museum professionals and others concerned with visitor learning and behavior in informal settings; stimulate discussion and practice of the Excellence and Equity guidelines and principles; stimulate an awareness about the diversity of settings appropriate for visitor studies; increase the understanding about the application of visitor studies to outdoor recreation and natural resource settings; enhance higher education and public natural resource agency involvement in visitor studies research.

**November 1996**

Australian Model Solar Car Challenge  
Location: Adelaide, Australia  
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In November 1996 students from across Australia will meet in Adelaide to compete in the Australian Model Solar Car Challenge, the culmination of state-based challenges conducted from September to November in New South Wales, Victoria, Queensland, South Australia, Western Australia, Tasmania, and the ACT.

**December 27-30, 1996**

NSTA International Convention  
Location: San Francisco, CA

The convention, to be chaired by NSTA Executive Director Bill G. Aldridge, will bring together scientists and K-college science educators from dozens of science and science education societies and organizations worldwide. Invitations have already been sent to societies in more than 30 countries. Holding the event in San Francisco, it is hoped, will especially encourage participation from Pacific Rim countries.

At this convention, participating teachers and science educators will present sessions in their areas of expertise (interdisciplinary approaches are encouraged) to scientists who are not as familiar with the classroom. In turn, scientists will present sessions about their work to nonspecialist scientists and to educators less familiar with the latest news from the research laboratory.

**1997**

**South African Conference**

**Eastern Europe Conference**

**10th ICASE-Asian Conference**  
Location: Lahore, Pakistan

Science Education International, Vol. 6, No. 4 December 1995
Extending and Improving Education in Science
for All Children and Youth by Assisting
Member Association Throughout the World

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Science Education International is the Quarterly Journal of the International Council of Associations for Science Education. ICASE was established in 1973 to extend and improve education in science for all children and youth by assisting member associations throughout the world.

This journal provides a means for associations, institutions, centres, foundations, companies and individuals concerned with science education, to share perspectives, concerns, ideas, and information which will foster cooperative efforts to improve science education, and which will serve as a chronicle of the advancement of science education throughout the world.

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ICASE News
Lithuanian Association of Chemistry Teachers 2
ASTE '95—Durbin, South Africa 2
The European Science Education Research Association (ESERA) 3
A Visit to Instituto Do Desenvolvimento Da Educacao (INDE) Mozambique 3

Feature Article
The Role of Science Teacher Associations in Promoting Scientific and Technological Literacy 5

Science Education Around the World
Recruitment of Science Teachers 11
Does a Multicultural Treatment of Science Guide or Disguise Science Classroom Dilemmas? 13

Research on Curriculum, Teaching & Learning
Professional Development: The Iowa Chautauqua Model 18

Science Teacher Education & Leadership
Breaking the Cycle of Mediocrity: A Systems Solution to an International Problem 22
A New Integrated Inservice Course for Science Teachers 26
A Journal Entry With a Message 29

Calendar 31

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LITHUANIAN ASSOCIATION OF CHEMISTRY TEACHERS (LACT)

LACT currently has 97 members comprising chemistry teachers from secondary schools, University lecturers and staff of the in-service teacher training institute. The corresponding person is Regina Jasiuniene based at the in-service training institute.

The Main Aims of LACT
- to develop creative and social activities for chemistry teachers;
- to collect and disseminate the latest information on research and methods of teaching;
- organise conferences, symposia, meetings, exhibitions and publications;
- propagating the best chemistry achievements;
- to build networks and professional contacts of chemistry teachers and connections with other Lithuanian organisation and associations, thus supporting cooperation;
- to provide LACT members with new teaching materials;
- to initiate nature protection problem solving;
- to promote Chemistry Teachers’ professional development;
- to support new projects on Chemistry teaching;
- to influence the Ministry of Education and Science in their decision making concerning the priorities for Chemistry teaching; and
- to defend the interests of Chemistry teachers.

ASTE '95—DURBAN, SOUTH AFRICA

During the week of December 4 1995, a group of more than 100 African science educators and scientists met at the University of Durban-Westville (UDW) in South Africa. The occasion was the African Science and Technology Education meeting titled, “Towards the Future: Practice, Policy, and Priorities.” At a time when many wonder about Africa’s place in the world—the Ugandan leader Yoweri Museveni, for example, recently published an article titled “Does Africa Count?”—many also recognize the need to improve education for African children if Africa is to take its rightful place in what has become the Global Village. Certainly science and technology must be an important part of that education.

ASTE '95 was thus held to define philosophy, practice, research, policies and priorities for science and technology education in Africa with special regard for women. Organisers also hoped that the meeting would promote collaboration amongst science education policy makers, practitioners, and donors. The conference participants also included long time friends of the continent, most notably the very distinguished Phillip Morrison of Harvard University and Professor Jerry Pines of the California Institute of Technology. The conference discussions centred on key issues: historical perspectives, science and technology for development, curriculum issues, political and hegemonic issues, equity, teacher education, resources for education, philosophy and theory, research, and media issues.

The conference organisers under the direction of Mr. Prem Naidoo (UDW) are now compiling conference papers and notes to be published as a proceedings. It is anticipated that the group will meet again in two years so that progress can be assessed. The meeting was sponsored by The African Forum for Children’s Literacy in Science & Technology, The Rockefeller Foundation, The Norwegian Agency for Development Assistance, the University of Durban-Westville (RSA), and the Foundation for Research & Development (RSA).

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THE EUROPEAN SCIENCE EDUCATION RESEARCH ASSOCIATION (ESERA)

ESERA is a new association formed at the European Conference on Research in Science Education held in Leeds, England in April 1995. Participants agreed upon a draft constitution and elected an executive committee. The Aims of ESERA include:

- enhance the range and quality of research and training research in science education in Europe;
- provide a forum for collaboration in science education research between European countries;
- represent the professional interests of science education researchers in Europe;
- seek to relate research to the policy and practice of science education in Europe; foster links between science education researchers in Europe and similar communities elsewhere in the world.

Activities will include summer schools for Ph.D. students (the 1996 programme will be in Barcelona but probably restricted to European students) and a conference every two years (Rome in 1997, Kiel in 1999, open to everyone).

Membership is open to Science Education Researchers from any part of the world. As it was determined that this should be a professional association of academic standing, applications for membership should be accompanied by a brief curriculum vitae showing evidence of research in science education, and the nominations of two established science education researchers (not necessarily members of ESERA).

The subscription is currently 50 Dutch Guilders (about 22 pounds sterling or $35, but you need to add the cost of transfer).

For further details and an application form, please contact the secretary.

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A VISIT TO INSTITUTO DO DESENVOLVIMENTO DA EDUCACAO (INDE) MOZAMBIQUE

Dennis Chisman and Jack Holbrook

Introduction

At the invitation of INDE, an ICASE member institute, we were able to give a number of lectures and seminars on science education development in Mozambique. The visit was made possible by a grant from the Royal Society of Chemistry.

The timing of the visit was arranged to fit in with a visit to South Africa to discuss arrangements for a major international conference on science education to be held in 1997 in collaboration with the International Council of Associations for Science Education (ICASE).

Seminars

Seminars were held in INDE and the Pedagogical University based on curriculum development in science and, in particular, on Project 2000—a joint project of UNESCO and ICASE—for the promotion of scientific and technological literacy. In addition, one seminar was given on primary science education, promoting Stepping Into Science, the ICASE project designed to encourage investigations at the primary level by giving certificates to students for taking ‘steps’ into science (for more details on this scheme, contact the ICASE Primary Science Officer—Dr. Sue Dale Tunnicliffe).

The participants in the seminars included some of the academic staff of INDE and the Pedagogical University, together with the teacher trainers and a few teachers. In addition, foreign advisers working in science education in Mozambique, including a Russian specialist (Dr. Oleg Popov) and a Dutch United Nations Volunteer (Sylvia den Hengst).

Impressions

Mozambique is a very poor country with little or no resources for education. The teachers are poorly paid and lowly qualified. Most of them have more than one job. There is very little motivation for professional development of teachers or for the formation of professional associations of teachers. Nevertheless, there are pockets of enthusiasm—one such is INDE—and the National Teachers Organisation is already organising some inservice courses. The participants at the seminars showed much enthusiasm and were very willing to be involved in activities. Many showed creative skill in putting activities into place with very little equipment. The need for this was amply illustrated on a visit to a primary school just outside Maputo.
The school, covering grades 1-5, caters to 1076 students in 23 classes with only 14 teachers. If this is difficult enough to imagine then add to this that the 7 classes need to function at any one time in a 2 classroom school. Five classes are held under trees outside the school. At the time of our visit the school was not in session and all the school equipment was packed and placed in the headteacher’s room. There was space as the room held little in the way of furniture. All the equipment for the entire school was stored in 3 cardboard boxes, each about 0.5 x 0.3 x 0.3 meters. The classrooms were sparsely equipped and besides a table and chair for the teacher, and a blackboard, there were desks that could cater to about 10-12 students (the rest sat on the floor).

Acknowledgments

We both wish to record our thanks and appreciation to the Royal Society of Chemistry for the grants which enabled this visit to Mozambique. We also wish to thank those colleagues in Mozambique who received us and who arranged our busy 3-day schedule, not least the Head of the Zimpeto Primary School for so graciously receiving us and answering our many questions and to Dr. Oleg Popov who made it all possible.

ICASE HAS A NEW HOME PAGE

ICASE is now available on World Wide Web. As we all know, communication within and among our organizations is crucial. We must explore all possible avenues for improving both the quaintly and the quality of our interactions. The World Wide Web has tremendous potential with it’s ability to provide print material, color photographs, and even short film clips from one location.

ICASE President Brenton Honeyman has been busy exploring how this latest communication tool might help all of us. His efforts may be viewed at the following location. Please add this home page site to your bookmarks and plan to visit us regularly: http://sunsite.anu.edu.au/ica.

Increase Communication

Let us know how we may help you and your organization. Send us e-mail comments, suggestions and even articles electronically. If you have access to internet, we would like very much to hear your suggestions as to how ICASE can better serve your needs. Send your comments to:

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THE ROLE OF SCIENCE TEACHER ASSOCIATIONS IN PROMOTING SCIENTIFIC AND TECHNOLOGICAL LITERACY

Jack Holbrook
Executive Secretary
ICASE

Introduction

Articles in Science Education International, as illustrated in the December 1995 issue, are showing the emergence of a new direction for the teaching of science subjects. The importance of relevance in science education is beginning to shift teaching towards issues and concerns of society either by making these stated areas of study within the curriculum, where traditional academic chapter titles are maintained, orienting the teaching approach within the topic towards such issues or concerns. The former can be related to the outcomes of an ICSU CTS conference in India (Bangalore, 1985) on science and technology education for future human needs, where teaching areas were suggested as—Health; Food, Land, Water and Mineral Resources, the Environment, Energy, Industry and Technology, Information Technology, Ethics, and Social Responsibility.

With this in mind, it is time, if it is not already the case, for science teacher associations to consider the teaching directions they would wish to promote for the 21st century. This is important now. Whilst it might be fairly easy to change the curriculum, or the textbook, or even an external examination, it appears to be much more difficult to persuade teachers to change their science teaching philosophy and their approach in the classroom (or laboratory). For many teachers the move towards teaching science appropriately to all students is likely to prove very difficult. It is also likely to be difficult to interpret the meaning of scientific and technological literacy within society and implement this in the teaching of science in ways that differ from the gaining of unrelated scientific conceptual ideas and an academic foundation in the sciences which is often perceived as important by scientists.

Project 2000+

Project 2000+ (1992), initiated by ICASE and UNESCO and officially launched in 1993, calls on both government and non-governmental organisations to rethink their philosophy towards the teaching of science and technology in their own country and to begin measures to help teachers meet the challenges of teaching science to all students in a relevant and meaningful way. The Project 2000+ declaration, strongly supported by ICASE and distributed to all ICASE member organisation, calls for measures and activities to be in place by the year 2001, a mere five years from now.

Project 2000+ suggests that STAs take note of trends and developments occurring in science and technology education over the previous 20 or so years and makes attempts to bring together the considerable and growing research outcomes with the needs of teacher educators and teachers. The major message is the need to pay much more serious attention to the scientific and technological needs of society for the 21st century and the way the intentions of science education are to be implemented in practice.

Federico Mayor, Director-General of UNESCO, in addressing the Project 2000+ conference on Scientific and Technological Literacy for All (UNESCO,1993), pointed out: “In a world increasingly shaped by science and technology, scientific and technological literacy is a universal requirement. If people are not to be alienated in some degree from the society in which they live; they are not to be overwhelmed and demoralized by change. They are to have the basic knowledge and understanding to make those multifarious political, environmental, and ethical choices with which discovery and its consequences are confronting us all.”

Possible Curriculum and Teaching Implications related to the Goals of Project 2000+

To promote relevant and meaningful science education for all students obviously calls for changes in the curriculum. But simply changing the content is not enough. Below are suggested a number of fundamental changes in the curriculum structure and the manner in which teachers approach the teaching of science subjects. The suggestions try to illustrate that basing teaching time on content alone is no longer appropriate. This will have obvious implications for the manner in which textbooks are used and where teachers place emphasis in their teaching approaches.

The implications of teaching for scientific and technological literacy for all are suggested as:
a) Science and technology will no longer be taught through a 'teach the fundamentals first', concept-led syllabus (the traditional academic approach). Other approaches which stem from societal or technological concerns and build on students' prior experiences which provide a basis for constructs to be formed will be seen as more relevant (constructivist theories).

b) Syllabus units will generally be expressed with societal, rather than academic, titles. This will encourage teaching units away from the concept first, 'application as an afterthought', approach. It will promote greater consideration of which science is really relevant and hence provide the rationale for selecting topics (from the excessive and ever-growing body of scientific knowledge). The old argument 'it is fundamental' will no longer be applicable.

c) Sequencing, within teaching units, will generally proceed from the societal situation, concern, or debate to a consideration of concepts and information needed for the unit (a breaking-down approach, starting with that which is familiar or topical), rather than attempting a systematic build up of background in a 'science facts first, applications second' approach (an approach going from the unfamiliar and trying to reach the familiar—often unsuccessful and students become bored!!).

d) Student participation approaches will be the main thrust of the teaching method and the intended time distribution will take note of the need for all objectives of the course to be achieved. (Basing time distribution on syllabus content rather than the course objectives has tended to promote a teacher centred approach).

e) Allowance will be made in the teaching time distribution for economic, ethical, social and political considerations within science topics. (Curricula developed, based on content, too easily become overloaded when time allowance is not included for contextual aspects and relating the place of science in the overall education arena).

f) More attention will be given to communication skills such as discussing, debating and role playing, rather than relying on pencil and paper skills, i.e. reports, plotting graphs, manipulating numerical or tabular data. It will be seen as important that communication skills relevant to society are developed through all subject areas.

g) More emphasis will be placed on problem-solving and planning skills. Transference of skills to unknown situations and the development of a scientific approach will be seen as far more important than acquiring isolated concepts, memorizing facts or even carrying out a number of set experimental procedures, based on 'textbook' instructions.

h) Although science and technology are experimental, this will not mean teaching theory first and undertake some recipe experiments or procedures afterwards. The scientific method will call for student participation in all processes of investigation, from identifying the problem and planning the investigation, to acquisition of the necessary knowledge, to analyzing the outcomes and their implications. Curricula will allow teaching time for students to acquire such skills.

i) Science and technology will be promoted with a positive rather than a negative image (syllabus headings such as pollution will need to be avoided) and will promote gender equity. Scientific and technological literacy will be appreciated as important for women and girls as it is for men and boys.

j) A greater link will be established between school science and technology programmes and agencies outside the school (museums, industry) which utilize or promote science and technology. For example, greater recognition will be given and better utilization made of the more exciting manner in which science and technology museums/centres are able to portray information and applications than is ever possible in the classroom situation.

The Potential of Science Teacher Associations to meet Teacher Needs

1. Arguably, the biggest obstacle to future progress is persuading teachers to accept and implement the changes being proposed by Project 2000+. Peer group interaction is seen as vital if teachers are to be persuaded that there is a need to modify their teaching strategies.

The role of science teacher associations is seen as crucial in this respect and this article is an attempt to persuade STAs that this needs to be a major consideration for the rationale of a STA within a country. It is no longer sufficient to help teachers with their day-to-day teaching in 1996;
STAs also need to help teachers prepare for teaching beyond the year 2000. This means a change of philosophy for teachers from that currently in place. STAs need to be at the forefront of such a challenge.

2. Primary school teachers, in so many countries around the world, need help. Often in-service teacher education seems unable to compensate for the lack of school-acquired interest and many teachers develop an inherent fear of teaching science, scared of making a mistake. Attempting a change of attitude and instilling more appropriate approaches to the teaching of science and technology represent huge and long-term undertakings.

STAs in some countries are recognizing the importance of primary science and are trying to help teachers at this level. This article tries to persuade all STAs of the importance of teaching substantial and exciting science at the primary school level. Gone are the days when secondary school teaching can ignore previous teaching and assume that students have no previous science knowledge. This article also tries to persuade STAs of the important role they can play in helping primary school teachers implement meaningful, relevant and exciting science and technology.

3. Many science specialist teachers need to change their outlook, philosophy and practice if scientific and technological literacy is to be more than a stated goal by curriculum developers. Specialist teachers in the science sub-divisions must be persuaded that they should not set themselves up as role models. There is always the danger that such specialization encourages science and technology to appeal only to few students at the expense of popularization of science and technology for the many. It is of crucial importance that teachers are guided to look carefully at the education they are providing for all students and ensure that their teaching strategies promote relevant science.

Science teacher associations can do much in this aspect.

4. Where teachers are not involved in the development of the teaching process and do not understand its goals, they are poorly prepared to implement any change. Furthermore they are usually poorly motivated to read any documentation about trends in science education, or the intentions of the change. In general, teachers rarely, if ever, read science education journals (Holbrook, 1992). They continue as before unless there are strong incentives for putting effort into change. Such incentives could be:
   a) change of the external examination (the usual stimulus for change)
   b) financial incentives for teachers (e.g., promotion, higher salary)
   c) teachers feeling ‘ownership’ and that their ideas and opinions are important and carefully considered
   d) strong and relevant (as perceived by teachers) inservice education presented to teachers as if teachers are part of a team and have expertise.

Whilst STAs, as professional bodies, are not involved in the welfare of teacher, e.g., salaries, there is much that STAs can do to involve teachers in putting forward ideas on increasing the validity of examinations, publicizing teacher ideas and opinions and in taking the lead in meeting teacher needs through peer group in-service provision.

5. An important approach in persuading teachers to try out new ideas is through the development of teaching materials that are attractive, easy to use and highly motivational for students. These materials can be directly related to the syllabus, e.g., reorientation of the approach to teaching, which has as goals
   (i) greater relevance to everyday life
   (ii) greater educational value in meeting skills
   (iii) greater student involvement
   (iv) more logical and interesting, looked at from the students point of view

   Or a number of alternative materials can be made available for teachers from which the teachers select whatever they consider appropriate. Choice increases the professionalism of teachers as teachers are called upon to make their own decisions and are thus required to think about their teaching strategies. Besides the above goals, these materials have the advantage that they could also
   (v) carry new scientific information
   (vi) be a source of information for teachers from which they then develop their own materials

Of interest here is the growing quantity of written ‘enrichment’ material being developed by non-Governmental groups e.g. (on the international scene) ICSU CTS and ICASE, (and nationally) science teacher associations, which endeavor to provide the teacher with add-on or possible replacement material for their teaching. Examples, internationally and regionally, are the materials on Global Change and Science in Space, Science across Europe, Science across Asia/Pacific, whilst
nationally SATIS (Science and Technology in Society) is a well known development by the
Association for Science Education in the UK. Science teacher associations are well placed to
publicize exemplar materials, to train teachers in the development of local materials and to initiate
and coordinate the widespread local production of such materials.

6. Once the classroom door is closed, lessons proceeds based on the skill of the teacher. The
teacher thus needs to be a professional and attempts to undermine this, are likely to lead to ineffective
teaching. There appears to be no such thing as teacher proof lesson packages that can be taught
irrespective of the traits of the teacher. Where the teachers is poorly equipped to deal with social
issues that demand a scientific input, or their science is inadequate to handle technological
issues, (as they only know the ‘scientists science’), more attention is needed to support and guide
teachers.

Science teacher associations are uniquely placed to recognize the needs of teachers and make
available updating provision that is appropriate.

7. Scientific and technological literacy is not a ‘have or have not’ situation. It is built up during the
process of schooling and guided and emphasized by concerns and needs of society. This does not
mean to say that every teaching topic should be provincial, because science is worldwide, the world
is a global village and concerns such as global warming, the ozone layer, deforestation,
environmental issues, health, energy resources and industrial pollution are universal. It does not even
mean that there is one global solution. Decisions needed in one community will reflect the priorities
of that community and these can differ from the priorities of another community, or even the same
community related to another time period. Science education is seen as having an important role in
guiding students in this realization and a model of science education solely promoting science ideas
that have a unique solution is no longer applicable.

Science teacher associations are able to play a major role in helping teachers relate their science
teaching to the decisions being made within society and hence enabling students to realize the societal
importance of developing scientific and technological literacy.

8. A bottom up approach to a recognition of the needs of teachers relies on peer group support playing a
major role. Teacher groups can play a major role in meeting actual, rather than perceived, needs.
Teacher groups are extremely active where developmental projects are widespread and it
should come as no surprise that teacher groups—science teacher associations—are instrumental in
the development of many of these—SATIS (UK), STAV Physics Series (Australia). An important
trend in the promoting of Project 2000+ ideas is the involvement of teachers, through teacher
groups such as science teacher associations. Such groups can play an invaluable role in raising
morale, in making available teaching resources, in provide support for the teacher, in stimulating
new directions and above all in the dissemination and monitoring of change. Project 2000+
advocates teacher groups by the creation of National Task Forces (UNESCO, 1993) in which
all groups interested in the development of education are represented and have a voice.

9. Teacher rely heavily on the use of textbooks. Research has shown that the more insecure the
teacher, the more the textbook dictates the direction and pace of the lesson. Promoting scientific and
technological literacy is a problem if textbooks concentrate on factual knowledge and conceptual
understanding and pay little more than lip service to the wider goals of science and technology
education. Unfortunately most textbooks, and even student workbooks, are weak in meeting objectives
such as developing problem solving, decision making and communication skills. Textbooks are
often geared to the assessment emphases of examinations and based on an examination syllabus, where scientific fundamentals are
highlighted. This promotes conceptual goals but makes textbooks poor in guiding attitudinal gains.

Science teacher associations are able to help teachers reflect on the choice of textbook, its
advantages and disadvantages. Also science teacher associations are able to help teacher
question the role of the textbook in their teaching so that the teacher is implementing the goals
intended, rather than those perceived as appropriate from slavishly following a textbook.

10. Training teachers with specialisms in interdisciplinary areas, such as sustainable
development, global change, assessment of risk, energy, etc. is rare and it is much more likely that
teachers have received their science education, both at undergraduate and, if applicable,
post-graduate levels, confined to rigid man-made divisions of biology, chemistry and/or physics.
Undergraduate programmes reflecting the interdisciplinary of science and drawing on a less
specialized school education are needed, especially in the preparation of future teachers.

Science teacher associations can play an important role in persuading tertiary institutes of
the need to provide a more balanced education at the undergraduate level.

11. Teacher background is also partly responsible for teacher intransigence to curriculum change. Science educators in institutes of higher education have a responsibility to reflect on the type and breadth of education that is needed at primary and secondary level, both for those undertaking science/technology and non-science/technology courses and to guide teachers accordingly through pre-service and in-service courses. This is especially true in developing countries where securing places at the tertiary level is highly competitive and examinations, governing selection, have traditionally emphasized factual knowledge and pencil and paper question-handling techniques, rather than scientific and technological literacy.

Science teacher associations, have an important role to play in increasing the validity of selection procedures and in breaking the cycle of inappropriate primary and secondary science education leading to teachers having backgrounds that make them poorly equipped to cope with change.

Partly the intransigence is guided by the poor professionalism of teachers, where the teaching emphasis, especially of specialist science teachers, is all too often guided by the demands of tertiary education, rather than by the needs of the student.

Science teacher associations provide a valuable channel for peer group support in recognizing how the curriculum should be interpreted and how the needs of all students can best be met.

The Role of Professional Teacher Associations

Related to the comments already made, major ways in which teacher, and more explicitly groups of teachers, i.e., science teacher associations, can be involved in promoting Project 2000+, and hence scientific and technological literacy, are suggested below. These have been grouped into those considered possible by any STA and those more likely only where the STA has sufficient resources, or additional support.

Level 1—Simplest level for STAs—should be possible for all STAs

a) By means of seminars, workshops on exemplary teaching and publications, such as a newsletter, persuade teachers to support the new direction and guide them to realize its educational potential.

b) Providing in-service support for teachers through seminars and workshops to introduce, plan trials and evaluate strategies and materials related to the new direction.

c) Developing support materials and other resources to help teachers prepare for a new direction and encouraging teachers to trial them in their classrooms.

d) Providing seminars, resources, etc., which teachers may find useful for updating their background knowledge in societal related (technological) science.

e) Producing a regular bulletin/journal on teaching ideas and developments in science education.

Level 2—Intermediate level where STAs are strong enough to be involved in curriculum development, guiding examination papers, policy making and textbook/workbook design

f) Encouraging teachers to activate ideas, monitor progress and allay concerns of teachers through coordinating action research geared to the teaching approach and the curriculum.

g) Commenting and forwarding submissions on the current curriculum and the examination system and putting forward ideas for greater curriculum and examinations validity in terms of the goals of science education. Involvement as an official representative on curriculum development and examinations committees.

h) Review textbooks with special reference to their validity in helping students attain Project 2000+ goals; publish such reviews in the bulletin/journal; run exemplary seminars by teachers that are geared to how to use textbooks and workbooks in science teaching.

i) In countries following the UNESCO suggested pattern and creating a National Task Force, playing a leading role as a member of a national task force in initiating and implementing projects.

Level 3—Higher level for well established STAs improving education by accreditation schemes, awards for excellence and taking measures to promote exposure to developments internationally

j) Development and running of improvement courses for teachers with certification and/or the accreditation of courses run by others.
k) Creation of groups to put forward policy guidelines, e.g., development of appropriate criteria for the implementation of awards for good teaching; making such awards.

l) Running symposia with regional and international links, encouraging members to attend meetings overseas and the organisation of educational tours.

The involvement of teachers within a country in science education development is growing through engaging science teacher associations in areas such as developing the intended curriculum, the needed resources materials, the in-service support for teachers, the evaluation of the curriculum, dissemination and implementation, and modifications to the course in the light of developments (see for example articles in the Science Education International, the ICASE quarterly journal). Furthermore with the growth and involvement of teachers through science teacher associations, there has been a growing tendency to encourage classroom research where the teacher is recognized as a researcher. Data from actual classroom practices should prove invaluable in promoting scientific and technological literacy.

ICASE has been instrumental in helping the formation of professional teacher groups (often called a science teacher association although the actual name and orientation is in line with current curriculum practices and governmental—non-governmental alliances within a country). These groups, involving teachers, almost invariably involve teacher educators, Ministry of Education inspectors, curriculum developers and often person from industry. ICASE is delighted to help any group to form a professional association interested in furthering education in an area of science and technology at the primary and secondary level, irrespective of location, language or financial status. For more information contact the Executive Secretary.

References

ASTRONOMY ACTIVITY AND RESOURCE NOTEBOOK PUBLISHED

The Universe at Your Fingertips, an 813-page astronomy activity and resource notebook for teachers in grades 3-12 (and astronomers who work with them), has just been published by the Astronomical Society of the Pacific. The loose-leaf collection includes 90 hands-on activities, dozens of annotated resource listings, featuring reading material by topic for students and teachers, and audio visual aids, computer software, and organizations that assist teachers, as well as a catalog of national astronomy education projects. In addition, the notebook contains articles on student learning, astronomy basics, and fitting astronomy into the science curriculum at various levels.

The Universe at Your Fingertips is $24.95 plus $6.00 for shipping and handling to U.S. addresses. California residents please add sales tax. Send orders to Astronomical Society of the Pacific, Notebook Order Dept., 390 Ashton Avenue, San Francisco, CA 94112; phone 800-335-2624.
RECRUITMENT OF SCIENCE TEACHERS—THE GATEKEEPING
FUNCTION OF INITIAL TEACHER EDUCATION
By John Oversby
The University of Reading
Bulmershe Court, Earley, Reading, UK

Introduction
In many countries, teachers in publicly funded schools have to hold a recognised qualification to teach. Recruitment to the courses which provide this qualification is, therefore, an important gateway through which potential teachers must pass and, therefore, provide an essential gatekeeping role. This article describes the practice, and the theory behind this secondary science teacher education course at The University of Reading in England.

This new postgraduate course was established in 1993. School teachers and university tutors formed a partnership to design course content and methodology. Recruiting suitable candidates for a course in which students spend two-thirds of the 36-week programme in schools became a significant issue. The course was to identify desired student teacher qualities and value decision making by teachers and tutors equally. The reflective practitioner model of student teacher learning was adopted by the Reading Schools Partnership while respecting the influence of other educational theories and recognizing local context in which teaching takes place before decisions concerning planning, teaching methods, or lesson evaluation. In no way is the model simply an acceptance of theories or of traditional school views. Student teachers are expected to critically examine research and practice aimed at producing personal theories about education. The resulting understanding will underpin everyday practice of their teaching for years to come.

The following criteria formed the characteristics necessary for candidate acceptance:
• open to new ideas in a critical framework;
• willing to learn about science and about science education;
• committed to secondary science teaching (11-18 years old); and
• thoughtful about science education and its purpose.

The process of recruitment also created the need to assess these characteristics.

Application and Selection
Application forms are received from the Graduate Teacher Training Registry throughout the year. Applicants’ forms are sent to one Higher Education Institution at a time for consideration. An offer from that institution and acceptance by that candidate completes the process.

Applicants are required to have a degree in science or a science-related subject (e.g., engineering). In addition applicants must have mathematics and English grades of a “C” or equivalent. Students are placed in schools where they are expected to teach all sciences to 11- to 14-year-olds, two science to 14- to 16-year-olds, and one science to 16- to 18-year-olds. Originally, only these students who had studied all three sciences up to 16-year-olds and two from 16 to 18 were invited for an interview. This proved too restrictive for physicists and so they were required only to have studied two sciences to 16-year-olds and one from 16 to 18. Perhaps this is a case of market forces in action. We also were aware that some groups are under-represented in our course and it was decided to relax requirements for females in physical sciences, ethnic minorities, and for some students who had taken an unusual route to gaining a degree, such as studying part time. Such applicants were invited for interview even if they had studied only one science.

Applicants are required to provide a reference. The reference comments are extremely variable and many are simply judgment statements with little evidence to support their evaluations. These are ignored. Negative references indicating characteristics such as lack of commitment or unreliability are rare but usually lead to rejection.

Most applicants give positive reasons for wishing to teach, such as enthusiasm for the subject or wishing...
to give something back to the community. Many had some involvement with teaching in some form or another; for example, teaching their own children or working on summer camps. Males are more likely to have little or no experience.

Applicants are instructed to visit at least one science lesson being taught to 11- to 14-year-old pupils in a nonselective publicly-funded school prior to the interview. Assistance with this arrangement is given if needed.

The Interview

It is usual to invite six to eight candidates at one time. Interviews are conducted by a tutor and a teacher. The interview begins with introductions and a description of the course, emphasising its professional nature and the seriousness of the commitment they are being asked to make. Opportunities for asking questions are provided frequently throughout the half-day process.

A group interview of about 20 minutes provides an opportunity to listen to the applicants’ ideas and see how they work in a group. The group is given a task which to consider themselves as science teachers in a school making suggestions for improving science teaching. Cards with various suggestions, such as setting classes by ability, or by gender, improving staff understanding of research in education and using more computers, are provided and the group has to come to a conclusion about the relative importance of these suggestions. A checklist is used by the teacher and tutor observers. Individual comments are frequently taken up in individual interviews later. In general, contributions during this session are often very good but candidates who dominate unduly, those who make little contribution, and those who find difficulty in expressing their ideas give cause for concern.

Individual Interviews

During the individual interviews which follow, applicants are required to write about their visit to a school. The purpose of this activity is to check their writing ability. The writing also serves as additional evidence regarding their beliefs concerning teaching.

Each applicant is interviewed separately by a teacher and a tutor. These 15-minute sessions focus on different aspects of the applicant. The teacher questions views about the classroom and the tutor gathers insights concerning educational theories and principles.

The teacher’s questions cover the following areas: learning based on the school visit level of interest in teaching all sciences; interest in teaching pupils of all abilities; and interest in being a form tutor with pastoral responsibility.

The tutor’s questions cover the following areas: the applicant’s view of science as a subject; the relationship between teaching and learning; commitment to the intellectual challenge in learning about education; and the applicant’s expectations of the course. It is inevitable, in such a short interview, that some areas will not be covered, and this is acceptable.

The Final Judgment

It is assumed that the applicant already has the requisite subject knowledge. Given the fundamental characteristics required for acceptance mentioned above, the tutor and teacher attempt to reach an independent decision on the acceptability of each candidate. Agreement to accept or reject leads to an easy decision. However, a disagreement between the two judges leads to a rejection since the applicant needs to satisfy both partners, school and university. Excellence in each characteristic is not required for acceptance, simply an indication of a minimum standard. Applicants have generally expressed satisfaction with the procedure with only one complaint from more than 100 interviewed.

Applications from biology graduates have been good, leading to a high proportion of acceptances. Applications from chemistry and physics graduates are declining both in number and quality, particularly from males.

Summary

Teachers and tutors have agreed that personal characteristics are an important part of the selection procedure and should be the main focus of interviews. At each stage, minimum criteria are established and applicants failing to reach this minimum are rejected. At the final stage, those with acceptable characteristics are offered a place in the course. Experience with the 1995 entry process found that some candidates who accept the offer of a place to search for alternatives and subsequently withdraw. This is more frequently the case for men (six withdrawals) than for women (two withdrawals) and more so for physics (seven withdrawals from 14 acceptances). Biology only hand 1 withdrawal from 20 acceptances.

Editor Comment

With limited resources and the need to maximize our efforts toward only those who truly qualify, we must continue to explore early identification strategies. Please share your own experiences and strategies by submitting brief project descriptions and results to SEI.
DOES A MULTICULTURAL TREATMENT OF SCIENCE GUIDE OR DISGUISE SCIENCE CLASSROOM DILEMMAS?
Dr. Randy Yerrick, East Carolina University
Mr. Jeff Nugent, East Carolina University

Author’s Comment
As you read this article please contemplate comparisons that might exist in your own country or classroom context. Many times new insights can be gained by reflecting upon these differences and similarities around the world. The issue of multicultural science education has at times been quite heated in the United States. The solution has not yet been found for such a complex problem. Our perspective is meant to stimulate and perhaps complicate ongoing conversations between those who research and those who teach. We welcome responses, comments, and reactions to our perspectives and hope it serves ICASE mission to examine ways of promoting scientific literacy for all students around the world.

Introduction
Few would argue that American education is often shaped and determined by its response to trends, issues and movements within social and cultural contexts. Indeed it is difficult to see how it could be otherwise. The development of the American curriculum has in many ways been a struggle of representation with deep political investments. Questions like, "Whose voice should be valued?" and others surrounding the development of multicultural influences on education are a testimony to this fact. But it is important to remember that current science education reform (AAAS, 1989; CA Framework, 1992; MI Framework, 1991; National Science Education Standards, 1995) promote a notion of scientific literacy. For first time in science education history, has been targeted as not for one specific audience but for all citizens. Can an emerging multicultural perspective help to achieve the calls for national and international reform? How does such a perspective help to identify or detract from important issues of study and attention overlooked in the past?

Multiculturalism: A Movement Informed By Many
The lack of consensus regarding what constitutes multicultural curriculum or pedagogies lead one to suspect that it has yet to develop the support to mature into a movement. But some argue that the concern for and mobilization of multicultural education as a movement began during the era of the Civil Rights Movement in the 1960’s. It was during this time that America as a nation was involved in social upheaval primarily concerning the unequal treatment of African-Americans, women and other marginalized groups. The 60’s were a time of tremendous social change, where those with power and authority came under increased scrutiny and pressures to change. Schools were not immune to these demands. In some ways the development of multicultural education can be identified as a response to the demands for social equality brought on by the Civil Rights Movement.

Historically speaking, the promoting of the term literacy as an educational standard also exemplifies social injustice. Scholars such as Apple, (1990) Michaels and O’Connor, (1990), Anyon (1981), and Oakes (1985) have well reminded us of the role of schools and the unjust effects schools’ embracing of constructs like “literacies.” Schools themselves have taken on (or been forced to adopt) the role of privileging certain achievements and attributes (Willis, 1977; Anyon, 1981; Apple, 1990) for preparation of citizens for the appropriate role in the workforce or society. In the process of privileging certain “literacy” many researchers have reminded us that one discourse cannot be held up in high regard for attainment without another being considered less important (Au, 1980; Heath, 1986; Warren and Rosebury, 1991; Michaels and O’Connor, 1990; Anyon, 1981; Delpit, 1988). Schools themselves have played the role of privileging certain discourse often to the demise or counter production to the achievement of students. Only when the students life outside the school was investigated did researchers begin to understand how school discourse ran counter to what students had come to know, value, and make sense in their school experience.

The Role of Science in Asymmetry
Past science reform efforts and their subsequent implementation into school science courses have played large roles in historically stratifying students. Curricula, implementation, and pedagogues of choice have been matched by decreases of minorities in science classrooms, especially college preparatory and advanced placement courses, and have exacerbated existing differences among students. Lemke has argued that one mechanism for this stratification is through the treatment of scientific knowledge in such abstract and rhetorical ways that it has restricted membership and achievement within the ranks of school (1990). Many scientists argue
that maintaining a rigid sense of important concepts and ways of producing knowledge is important for retaining the integrity of the discipline without recognizing such effects on outsiders. While it may be important for science classes to reflect the discipline, few have discussed how restrictive membership actually promotes high prestige and subsequent elitism.

Science is a complex discipline to make accessible to all students. As an example, to become a physicist Traweek (1988) documented that students become familiar with the heroes and success stories of past achievers. Her textbook analysis revealed that most depictions were of serious, rational, anglo males scientists. This was the standard that physics graduate students were to aspire. In light of science education reform efforts, exclusive membership is not a desirable component of the scientific discipline in schools and to reflect this is contrary to the charge of “science for all.”

The United States is an always has been tremendously diverse; socially, culturally, ethnically, racially and sexually. Many believe that institutions and people who have traditionally been and remain in positions of power—predominantly rich, white, anglo-saxon males—have maintained their power by marginalizing minority populations and treating them unequally. To recognize the role of school science as restricting its membership in any way is to suggest nothing less than social reproduction, which in many ways has precipitated devastating effects on minority children and females (Bourdieu, 1977; Bowles and Gintis, 1976; McCarthy & Crichlow, 1994; Apple, 1990; Kozol, 1992). How to correct those past educational wrongs is an ongoing debate. The call for multiculturalism in schools represents an attempt to bring about equitable changes in American education.

**Multi-faceted Response**

In the attempt to correct educational misrepresentation and injustices some multiculturalists are concerned with promoting what can be called cultural awareness. This involves advocating cultural diversity and recognizing it as central to American culture. This group of multiculturalists is most interested in promoting inclusive language in textbooks, having images and pictures in textbooks depict the range of culturally diverse people in America. There is also an emphasis from this perspective to include and make known the contributions of traditionally marginalized groups (African-Americans, Asian-Americans, Latinos, Native-Americans, and Women) to the various fields of knowledge. That is, they view multiculturalism as developing curriculum and lesson plans that create an awareness of the diversity of American culture.

Some of these efforts are informed by research on learning style research of varied cultures (Atwater, 1994). There are additional efforts originating from this camp to develop bilingual programs for non-native speakers as a means of preserving their own rich cultural heritage. Such positions are coming under increasing scrutiny for not expounding upon the context in which studies are conducted. It has been argued that such a treatment of minority concerns could be responsible for promoting categorical claims, delineation of learning, and the elimination of any cultural gray areas of the social context (communities and classrooms). There exists the danger of naive or uninformed readers taking such recommendations as laundry lists, exhaustive by nature and collections of quick prescriptions for complex problems.

Another facet of multiculturalism maintains that diversity is not just to be tolerated through awareness, but must be recognized as an essential and necessary component of a democratic nation. It is from this assertion that resistance to multicultural curriculum development seems to have taken a dramatic turn. The curriculum itself becomes a site of struggle for representation and the outcomes and demands placed on education are transformed into debates and struggles for representation. Take for example the heated controversy which ensued in New York state over the Rainbow Curriculum, which in addition to a focus on African and Native-Americans had included materials which discussed homosexual lifestyles. The Rainbow Curriculum was initially adopted for use in NY but after severe protests the entire curriculum was replaced by a more traditional curriculum. Clearly there are deep investments in maintaining what can be considered multicultural. The American curriculum is itself a site of struggle about representation and identity, and there are very powerful interests that influence its content, shape and development.

Another facet of multicultural education wages its battles outside school contexts. There is an ongoing intellectual struggle over the very meaning of multiculturalism that is concerned with interrogating the social institutions themselves and determining the ways in which they contribute to the reproduction of social inequality and oppression. There is a concern for understanding not only the representation of minority and marginalized groups, but also a concern for critiquing the ways dominant culture is represented and reproduced. Those involved in this aspect of multiculturalism are committed to theorizing about the relationships between identity and representation, as well as understanding the very real connections between knowledge and power.
Yet Multicultural Attempts Fall Short

One dilemma of adopting any single perspective of multicultural science to view diverse classroom is that a single criteria cannot be applied to both science and school contexts. (People use totally different lenses to compare the two different communities and cultures.) The scientific community has for centuries been judged by a self promoted and skewed perspective on the values, process, and products of its community. It is by these highly refined sets of concepts at the end of a long and arduous venture that populations of students despite their background, have been measured. “Did students understand and correctly apply the concept of photosynthesis to this problem,” is the question that is often asked, failing to recognize that the scientific community themselves took hundreds of years to develop such a view of the world.

Currently, researchers are beginning to question the long held claims of virtues of objectivity, rationality, and even factuality (Traweek, 1988; Mayr, 1982; Fleck, 1979; and Latour and Woolgar; 1975). Closer examinations of real laboratory life has revealed other aspects of the scientific community before denied and kept beneath the surface. As Latour and Wolgar (1975) have argued there is a growing public,

“dissatisfaction with outside observers’ reliance on scientists’ own statements about the nature of their work... procedures and achievements central to scientists’ work become largely immune from sociological explanation. Approaches which implicitly adopt this standpoint have been roundly criticized on several grounds... Many of these analyses exemplify sociologists separation of the “social” from the “technical.” Much criticism concerns the lack of empirical basis for the ethos of modern science which these analyses outline. More recently, it has been pointed out that the existence of norms and counter norms in science derives from the insufficiently critical appraisal by sociologists of scientists statements to outsiders about their work... . Even if the norms he specified were found to be correct, the sociologist might just as well be describing a community of expert fishermen, for all he tells us about the nature or substance of their activity.” (pp. 22-24)

In other words, it seems impossible to investigate any questions about the compatibility of two vastly different communities unless there exists a consistent framework to apply to both. For example, it doesn’t make much sense how comparisons can be made about how rural blacks learn science that keeps them out of science as a discipline without also considering how scientists learn within their culture. From a pedagogical perspective one can make claims about school science being discriminatory, but this doesn’t mean that science as a discipline is discriminatory for the same reasons. In order to understand these issues better, there is a need to develop another handle in which to grip these issues with. Gee’s construct of discourse (1987) is one such handle. By discourse, Gee refers to a

“socially accepted association among ways of using language, of thinking, and of acting that can be used to identify oneself as a member of a socially meaningful group.” (1987, p.3)

There are ways in which science and local discourse communities need to operate differently and, hence, have developed distinctly different ways of attending to the “work” of the community. Gee argues that other ways of viewing science will perhaps reveal ways in which aspects of diverse communities can be valued as well. Conversely, attempts to discuss the pedagogical approaches which appeal to women and minorities and science comes dangerously close to isolating school science from all the other factors influencing student achievement or to treating school science as real science. School science and real science are not the same and pedagogical issues relate only to school science. One must apply a different lens to understand why science is exclusive to minorities.

Falling short of such a broad acceptance and definition for a cultural discourse, diverse communities are portrayed in curriculum efforts and other science reform initiatives, only certain selected pieces are selected to examine and portray the culture as it “really” is. Rarely do we talk for example about valuing or privileging most or all of the controversial components like rap music and the like as acceptable in science classrooms (Lemke, 1994). Multicultural educational conversations have often referred to a sort of “museum display type multiculturalism” This will not suffice. We as public educators need to speak of multicultural education as something other than some sort of museum piece, cleaned-up to represent a view that is washed by an Anglo perspective of political correctness.

Conclusion

We have been seduced by science reform rhetoric that represents science as promoting truly multicultural opportunity and democracy while suppressing the fact that it has never been either. Yet, reforms state that scientific thinking can promote such ideals. If this is

ever to be accomplished, science educators need to adopt a different lens through which to view problems of teaching and learning science. Discussing science more as a discourse among members of a community as opposed to a list of concepts to be learned is but one example of such a shift. Science education as a discipline needs to develop new ways of talking about science learning, teaching, and scientific literacy if we are to better understand science classroom and ultimately influence the ways science is taught to "all."

We as a science education community are far from creating concrete methods of implementing reform visions that actually value all forms of discourse including science for all. The United States is in its own quandary about its melting pot image having not even addressed at this point urban vs. rural discourse perspectives of a science. Not to mention the conspicuous silence of literature regarding levels of education like lower track classrooms and different treatments of science at many levels. Past solutions to this problem have fallen short. Future solutions may also fail unless studies explicate the ways in which accepted classroom organization and treatment of knowledge runs counter not only to science as a discourse, but also how schools privilege certain cultural discourses above others. In addition, an understanding of how science is treated as a "second weeding" of those students who don't belong is essential.

Given the fact that multicultural education is a site of political struggle and is concerned with questions of identity, representation, knowledge and power, it is of little surprise that those who feel most threatened by change have mobilized forces to maintain their privileged positions. Hirsch (1987) and Bloom (1987) have argued that multicultural education is a threat to the cultural traditions in America, and that its further advancement stands to destroy the important notions of what "we" have come to see as valuable and important in western civilization. Their objections stand as a testimony to the strong investment some have made in marginalizing and oppressing minority populations. The fact is America has always been a diverse nation, yet the few in power have been successful at maintain the myth of a singular national identity by promoting and supporting a canonical school curriculum. It is the author’s opinion that resistance to such movements ought to be used as indicators of need and serve to focus attention. From the students who chose not to engage in new pedagogical, epistemological, and ontological treatments of science to the political activists seeking to confound the vision of science for “all Americans,” resistance is an indication of conflict between parties maintaining different but closely held values.

It is clear that part of the debate over the American curriculum is about identity, representation, knowledge and power, and as such it will remain an intensely political battle for some time to come. In many ways schools remain firmly entrenched in the middle of this battle. At the very least schools need to be committed to the fact that diversity is an essential and necessary component of democracy. Furthermore, schools should be places where students can engage in multiple dialogues with diverse viewpoints to discuss the notions of identity, representation, knowledge and power. Perhaps in doing so they themselves can begin the challenging task of developing and defining an education that is truly multicultural.

References


JOURNAL OF RESEARCH IN SCIENCE TEACHING

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Manuscripts are being sought which describe factors that influence science education in developing countries or detail emerging priorities for science education in the 21st century. Manuscripts ought to be theoretically and contextually grounded. For example, authors may wish to describe science education praxis grounded in Paulo Freire’s project of critical consciousness and liberation; or authors may describe ways in which the goals of science education are being constructed to advance a broader discourse oriented toward cultural struggle and possibility.

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This journal provides a means for associations, institutions, centres, foundations, companies and individuals concerned with science education, to share perspectives, concerns, ideas, and information which will foster cooperative efforts to improve science education, and which will serve as a chronicle of the advancement of science education throughout the world.

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ICASE News
New Member Organizations ...................... 2
NASST ............................................. 2
Anglophone Science Education in Rwanda .... 3

Feature Article
Nebraska Earth Science Education Network .... 5

Science Education Around the World
A Report on International Links .................... 9

Research on Curriculum, Teaching
& Learning
The Pupil Researcher Initiative ..................... 12

Teaching Materials & Strategies
An Experiment With Soapy Water ............... 14

Science Teacher Education &
Leadership
A New Integrated Inservice Course ............... 15
Implementing a Science Education Field
Experience .......................................... 18

Non-formal and Informal Science Education
Science Centres and World Wide Web .......... 20

Book Reviews ..................................... 23

Calendar ........................................... 27

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NASST

The Nepal Association of School Science Teachers was formed at a meeting held at Sanothimi on Friday Asadh, 2052 (30th June 1995). Present at the meeting were a group of interested science teachers from Kathmandu, Bhaktapur and Lalitpur districts and invited advisers from SEP, SEDP and CERID. It was stated that school science teachers have needed such an association for the past few years. It was unanimously agreed that an association should be established. The purpose of this association is to enable science teachers to meet and share their experiences, organise workshops and conduct seminars, exhibitions and other activities. These will be designed to motivate students and teachers, to improve the quality of science teaching and learning and to promote the public understanding of science and its applications in daily life.

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ANGLOPHONE SCIENCE
EDUCATION IN RWANDA:
A PERSONAL PERSPECTIVE

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Contrary to popular belief Rwanda appears, on the surface at least, to be working effectively. Electricity and water are available in Kigali, the capital and in most of the surrounding countryside except in the remote areas. Power cuts area fact of life but most big businesses are buildings have stand-by generators. The main roads are tarmac, although currently without street lights or traffic lights. The side roads are passable with care; it helps to have a four wheel drive but those leading to villages are used regularly by public transport (the ubiquitous 12+ seater minibus). Mines appear to have been cleared from the public thoroughfares.

There are road-checks, more frequent close to the borders with Burundi, Uganda and Zaire but these do not seem unduly aggressive so long as papers are in order.

My impression of the country, which is about the size of Wales, is of green, intensively cultivated terraced hillsides with deep valley bottoms, opening out to bush pasture to the north. There are several spectacular lakes and after the rains, waterfalls. Bananas, sorghum and beans appear to be the main crops, with tea and coffee plantations beginning to be worked once more. I saw several quite large markets with a good variety of vegetables and other goods for sale. Towards the north of the country herds of long horned local cattle are common, together with sheep and goats.

Evidence of the most recent war (1990-1994) is there when you look closely at the buildings, many of which show signs of damage or of recent repairs. Young soldiers with guns are stationed at major cross-roads in the city and at towns in the countryside; and both in the city and in the countryside the vehicles of the support agencies; WHO, UN, UNICEF, UNAMIR etc. are easily recognised. It is an indication of the relative peace of the country however that two large UN guns, complete in their wraps, could be left unguarded by the roadside awaiting collection.

There are two distinct groups of returned refugees to Rwanda; the first are those from the most recent war who are being settled, after a time in transit camps, in under-populated areas or communes. The national park, Akaghe, has become a focus for those with cattle. The other large group consists of those who have lived much longer in neighbouring anglophone countries; mainly Uganda and Tanzania. This latter group contains those who have been educated through the medium of English and includes professionals, many of whom have property and business interests in the capital. These Rwandans want anglophone education for their children.

In response to this demand, anglophone community schools have been set up. These are not government funded and are entirely self-supporting, charging fees and relying on grant-aid from overseas. Most of them have taken over existing government schools left empty by the war. These appear to have been systematically looted and vandalised so that although the basic structure may be sound there remains much to do in the way of repairing, re-roofing, making secure and re-connecting water and electricity.

All this has to be done by the school; pupils, parents and teachers working together. The head teachers of these schools have in the main been trained in Uganda and they are managing to attract back to Rwanda ever-increasing numbers of Rwandan anglophone teachers also trained mainly in Uganda with a minority trained in Tanzania, Kenya and Britain.

My task, funded by ODA through the Crown Agents, was to visit these recently established anglophone secondary schools together with several government schools with anglophone streams, to assess the feasibility of providing basic science equipment and textbooks in English to help with the teaching of science to overseas ‘O’ level equivalent.

Rwanda was formerly officially francophone with designated government schools containing anglophone streams. This, apparently, was never entirely satisfactory since textbooks and teachers could not be relied upon and the curriculum was not open to accreditation or validation through the mainstream francophone assessment procedure.

The country is now, officially, bilingual anglophone/francophone with Kinyarwanda as the common language of spoken communication. Many government ministers have come to appreciate that English is essential for access to aid and other economic support from countries such as the USA, Japan and China, as well as most of Europe.

There is, inevitably, still a tension between those who wish to retain their historic cultural ties with Belgium and France and those aggressively promoting anglophone educational practices. My impression is that this will continue until a common curriculum has been established, capable of being taught and examined in either language. To this end the Minister of Education
has set up a curriculum seminar to which key francophone and anglophone teachers, government ministers and other officials have been invited as a first step towards establishing such a common curriculum.

The university is also currently receiving supporting from the USA and Canada with the specific intention of establishing anglophone classes on a par with francophone. The long-term objective is to produce students bilingual in English/French, able to access classes in either language.

In working towards this objective teachers of English as a foreign language are clearly key people, together with those able to teach the school curriculum in English. The head teachers of the anglophone community schools have joined together to form the Rwandan English Medium Educational Service (REMES) in which all heads of anglophone schools as well as those of government schools with strong anglophone streams are invited to join together to promote anglophone education. This group has powerful friends in government and I was told that the ambassador-designate to the U.K. is being briefed by the REMES committee. It was this committee, through the offices of the then Chargé d’Affaires for the U.K., Lilian Wong, who contacted the ODA and obtained the promise of funding to support science teaching which the Crown Agents are now in the process of procuring.

The long term goals of REMES include the establishment of an anglophone teacher training college as well as polytechnic to provide much added technical competence. In the medium term they wish to set up a teachers’ centre to support the exchange of information teaching methods, equipment and materials as well as to provide a focus for the upgrading of untrained teachers and other in-service education. To this end they are seeking the support of overseas agencies to make limited in depth contributions to summer schools as well as more long-term commitment to projects such as teacher education.

Why the focus on science? The main clue seems to lie in the difference in teaching methods between anglophone (especially commonwealth) and francophone traditions. Science in anglophone countries includes biology, chemistry and physics, taught practically, (that is experimentally) with students using investigative methods. Francophone science emphasises physics with mathematics, with chemistry a poor second and biology linked with geography. The traditional method of teaching is through teacher demonstrations. Those teachers and parents returning from long-term residence in anglophone countries want to perpetuate the empirical, “hands on” methods by which they were educated, believing these to be more effective to student learning in science which they see as a key factor in the re-establishment of a united Rwanda.

🚀 Note to Member Organizations

Please ask your members to submit material to Science Education International. We are looking for:
• Teaching activities and lessons, especially for elementary
• Action research articles which talk to the practicing teacher
• Research articles which focus on practice, not research strategies
• Informal and nonformal articles which address “Things to do” in these settings

PLEASE INCLUDE PICTURES AND OTHER DRAWINGS OR GRAPHS.
Manuscripts may be sent to:
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Introduction

Understanding earth systems is required for developing practical solutions for environmental and natural resources problems on local, national and international scales. Improving peoples' understanding of earth systems and, more importantly, general scientific literacy at all levels, requires strong communication between professional earth scientists, science educators, and parents. The Nebraska Earth Science Education Network (NESEN) was developed to provide a mechanism for enhancing linkages between K-12 earth science teachers and the resources and professional expertise at the University of Nebraska-Lincoln (UNL). The Conservation and Survey Division (CSD) of the Institute of Agriculture and Natural Resources at UNL is the lead organization. CSD is a multidisciplinary research, public service, and data-collection organization including the state geological, water, and soil surveys, as well as a center for remote sensing and geographic information systems. State geological surveys, such as CSD, can be particularly effective in enhancing these linkages because of their local expertise, their access to data and publications, and their ability to relate to general audiences. Commonly, surveys also have access and linkages to broader university expertise.

The needs and concerns of Nebraska teachers (Gosselin et al., 1995) are similar to those addressed at numerous education-related meetings (for example, Mayer and Armstrong, 1990; American Geological Institute, 1991; Geary and Zen, 1993; Metzger, 1993). However, implementing solutions vary from state to state, region to region, and on an international scale, country to country, depending on educational policies, geographic and population variability (for example, rural versus urban), monetary and human resources, and available equipment and materials. NESEN employs multiple strategies to enhance and expand earth science education in Nebraska by working directly with teachers because they are the most effective means of reaching students. These strategies include: 1) participating in pre-service, in-service and other professional-development activities with particular emphasis on the annual state science teachers' meeting (this type of in-service training and support for teachers is essential since many do not have formal training or education in earth science); 2) providing an annual summer workshop series, as well as developing new workshops, on earth science topics as a basis for lesson-plan development (that is, combining the information and expertise available at CSD and UNL with the pedagogical knowledge of teachers into lesson plans and activities that are classroom ready—most of which are available on the NESEN homepage; and 3) enhancing statewide communication using electronic media. It is one of NESEN's goals to electronically transfer across the network Nebraska-relevant earth science educational materials. Although Nebraska-relevant material is the primary objective, the connection to the Internet also provides teachers with access to earth science and other information on a national and international level.

NESEN also recognizes that many of its members, especially those in less populated, more rural Nebraska, do not yet have the electronic infrastructure to connect to the Internet. Therefore, NESEN takes appropriate steps to work with these teachers. Some of these steps include: a quarterly newsletter and our annual NESEN Resources Guide and Directory (currently in its third edition). The Guide includes most of the relevant material that is on the NESEN homepage and, as mentioned earlier, extensive participation in the annual Conference.

NESEN currently has nearly 300 members. Of these 300, approximately 230 are K-12 Nebraska earth science teachers and 70 are post-secondary earth science educators from UNL and other post-secondary
institutions within Nebraska. In addition, there are several teachers and post-secondary educators who are members from outside Nebraska.

The purpose of this paper is to: 1) relate our experiences and progress on an electronic-communication pilot project funded by the U.S. National Aeronautics and Space Administration (NASA); and 2) describe a related project, Students and Teachers Exchanging Data, Information, and Ideas (STEDI), that has evolved as part of the grant.

**NASA-Funded Electronic Communication Project**

Through this project and a variety of other initiatives, including state legislative action, access to electronic connectivity will soon be available to all Nebraska teachers. Although the infrastructure will soon be available, there are numerous problems with implementing an electronic communication network among teachers, which in turn minimizes the effectiveness of this media. These problems include access to electronic media, software availability, and compatibility, relevance and usability of materials, limitations on the time teachers have to learn the system, and the participants’ apprehensiveness of computers and other electronic media.

The specific objectives of our electronic-communication project are to connect geographically distant classrooms to the Internet and distribute materials and information over the network. Pilot sites were selected to provide: 1) a broad geographic distribution; 2) a range in computer knowledge from novice to a moderate level of expertise; and 3) a range of grade levels from middle school to high school. It was also considered useful if the selected teachers had previous interaction with CSD and/or NESEN staff.

Complete electronic connectivity and/or computer hardware, as well as software support, has been provided to eight pilot schools across Nebraska. In order to help these teachers learn about the electronic network, a workshop was given by CSD and UNL Information Services in March 1995. Although the network focuses on teacher support, we recognize that their students are often more computer-literate and have more time to become familiar with the technology than their teachers. To take advantage of this situation, students also participated in this workshop with the intent of instituting “reverse mentoring”. In this program, student participation will reduce the time the teacher needs to learn the system and reduce the hesitancy of teachers to use electronic media. Although this reverse-mentoring process was instigated, its successful implementation was minimized because of varying school policies regarding Internet access by students and the fact that students availability changed from one semester to the next. In addition to the workshops, NESEN staff have spent variable amounts of time with the participating teachers helping them with computer configurations and hardware installations and addressing teachers’ questions about software and network access. We found that providing a computer and access to the electronic super highway was only the beginning of getting teachers on the “Net.” The teachers and their schools also needed local in-house technical support that many of them did not have.

To distribute information and materials over the network, we initially established an electronic bulletin board. With the development of the World Wide Web (WWW) and web browsers, we established a homepage (http://nesen.unl.edu/nesen.html) that contains detailed information about NESEN. Some of this information includes, but is not limited to: “Ask-a-NESEN-Scientist”; hundreds of earth science activities/lesson plans designed by NESEN teachers and pre-service teachers; lists of earth science materials that can be borrowed by NESEN members; newsletters; earth science announcements; activities, background and benefits of NESEN; information about the Students and Teachers Exchanging Data, Information, and Ideas (STEDI) project and access to STEDI’s data entry/retrieval system; an earth science feature of the month; information about the secondary science education program at UNL’s Teachers College; and many links to other earth science workstations. New information is being added to the homepage daily. For NESEN teachers who desire an email account, one can be provided to them through NESEN resources.

Interaction via email is common between NESEN members. Approximately 40 percent of NESEN K-12 members and 50 percent of NESEN post-secondary members reported having email addresses. NESEN has created several alias email lists for easy communication with most, or selected parts, of the membership.

The K-12 members with email access were surveyed regarding their interaction with the NESEN homepage and activity with the WWW. Seventy-five percent of the respondents said they knew NESEN had a homepage and approximately 50 percent had visited the site at least once. Inability to connect to the WWW was the primary reason for not visiting the homepage. A few responded that they visit the site at least once a week. Of the schools that can access the WWW 30 percent have teacher-only permission for access and 60 percent have student-supervision access. The remaining 10 percent allow the students to have unsupervised access (usually after some sort of agreement is made between the student and the school about appropriate access on the WWW.) Teachers were also asked if they found material on the WWW usable for their classes. Fifty percent said they found an
adequate amount of information. The remaining 50 percent said that most of the information they found was not suitable for various reasons (for example, too much preparation time required, supplies or equipment not available, supplies or equipment too costly, etc.).

STEDII Project

The STEDII project evolved out of the electronic-communication project as a way to focus the acquisition of educational resources from the Internet and the sharing of these materials with the other pilot sites. The current topic, weather, is ideal because students experience it every day and it is generally quite variable across Nebraska.

Along with the eight pilot schools, six other schools, which are independently electronically-connected, are involved in the project. As part of this project, students learn how to use weather instruments and proper procedures for collecting data. Where needed, NESEN supplied the schools with maximum/minimum thermometers, sling psychrometers (relative humidity instruments), barometers, anemometers (wind-speed instruments), and rain gauges. These instruments allow the students to collect the following data: maximum and minimum temperature, relative humidity, wind-speed and direction, cloud cover, barometric pressure and precipitation. Frequently, data is gathered in small groups in which the students learn teamwork and cooperative learning skills. Having every student in a group taking measurements has the added benefit of reducing the chance of significant error. Students eventually became adept enough at their data-collection activities to recognize “good data” from “bad data,” that is, the beginnings of quality control.

Additionally, some of the STEDII teachers use the weather data to teach other skills such as mathematics and statistics (means, modes, and medians), graphing, mapping and simple weather forecasting. Some schools have established weather clubs that continue data collection beyond the weather unit. In fact, several of the local newspapers ran stories about the school’s weather-collection activity and reported those data in their respective town newspaper. Students and/or teachers have also explored the possibility of finding partner sites in other parts of the state, country and world with which they could exchange data.

Originally, the data was exchanged between participating schools and the project managers at UNL via email. This added the advantage of students gaining experience and knowledge of email and the Internet. However, this method become mundane and offered little in terms of data use. Later, a homepage was created for STEDII (http://nesen.unl.edu/stedii/mmsearch/stediihp.html—or access may be made directly from the NESEN homepage) whereby data was entered and retrieved via an on-line form. The students enjoy entering the data via the WWW, which has encouraged them to further explore the resources that the WWW offers.

STEDII has had the bonus of developing a strong relationship with the secondary-science education program at UNL’s Teachers College and with its director, Dr. Ron Bonnstetter. As far as we know, this three-way linkage between the resources of a state geological survey, pre-service science teachers and in-service teachers is unique in the United States.

During 1995-96, four pre-service science educators, as part of the requirements of their science methods coursework, participated in STEDII. Each pre-service teacher was assigned two or three participating in-service teachers. The pre-service teachers provided some technical assistance to the teachers and offered ideas for activities using the Internet. In turn, the pre-service teachers were given opportunities and experience in working with practicing earth science teachers and use of the Internet in classroom situations.

The STEDII project has similar components and structure to another school/research interaction group on the Internet, the GLOBE (Global Learning and Observations to Benefit the Environment) project (http://globe.fsl.noaa.gov/). GLOBE has many more schools collecting data, but fewer types of weather measurements are taken. With numerous locations collecting data, not every school needs to collect data to provide an adequate spatial and temporal coverage to produce useful activities that allow comparisons between schools.

Program Benefits and Summary

K-12 students are the primary beneficiaries from NESEN activities, either directly through participation in STEDII or through other teacher-enhancement activities through which their teachers become more knowledgeable, the students will be better informed and more capable of addressing future environmental and natural-resources issues. The NESEN initiatives will provide teachers, many of whom do not have formal training in the earth sciences, the opportunity to get current technical information on Nebraska’s natural-resources issues.

Through our projects we have observed that technology can play an important role in improving K-12 education. Electronic technology provides teachers with a mechanism for expanding this knowledge and increasing their students’ access to new experiences. However, technology is only a tool and only part of the solution to our educational problems. Many fundamental changes are required within the educational system before these technological tools can be used effectively. Specifically, proper local technical
support must be available to ensure that frustration with the technology does not minimize its classroom implementation. Technical support should apply to both hardware and software. Time must be made available for teachers to not only learn the technology, but to learn what are the best pedagogical approaches for using this technology in the classroom. Addressing these issues is especially important in rural areas where local support may not be readily available. In concert with addressing local support issues, educational materials on the “Net” need to be created that are more user-friendly and focused on specific topics which support current curriculum guidelines, such as the National Science Standards in the United States. Proper development will allow Internet materials to be more efficiently implemented in the classroom. Finally, local cooperative partnerships and communication systems, such as those used by NESEN, are required to improve the quality and effectiveness of science education.

References

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Increase Communication

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A REPORT ON INTERNATIONAL LINKS IN 1995 AND THE ANNUAL MEETING OF THE ESTONIAN CHEMISTRY TEACHERS

Miia Rannikmae, Secretary EACT

The annual winter meeting of the Estonian Chemistry Teachers has, by now, become a tradition. This year is the 26th time for chemistry teachers to come together and the second under the umbrella of the Estonian Chemistry Teachers Association.

But this year marks a significant change. Since joining ICASE in 1995, EACT has started to think more about the international network at the ordinary teachers level. The major efforts in recent years in the political arena in Estonia have been focused mainly on the economical problems faced by all and the need to rethink the education system. As a consequence the school curriculum is currently undergoing a change and science curricula for 1997 will have new subject content. And the planned course at the grade 7 level introduces new science teaching ideas unfamiliar to teachers. To put this into practice will involve the teacher adopting unfamiliar approaches, a step never needed in the prior—Soviet times, when teachers only needed to rely on their own experiences. This means teachers now need to be aware of what is going on in other countries and of the major priorities and directions in the field of science education. Only then are teachers able to play a useful role and influence the direction of curricula change. With this in mind EACT joined ICASE in 1995 and became involved in the international scene.

THE EACT’s International Links in 1995

In January 1995, the ICASE Executive Secretary, Jack Holbrook, accepted our invitation to talk to our association and by giving seminars in different places of Estonia, introduced teachers to the philosophy of Project 2000+ and the goal of science for all. An early EACT decision was to follow these ideas and think more about how to promote scientific and technological literacy among students. It was recognised that this would prove to be a time-consuming process as not all the implications of Project 2000+ are acceptable in the first instance, because of pressures from and familiarity with the old-system.

In May 1995, EACT together with IOSTE (International Organisation for Science and Technology Education), ran the first Central and East European Symposium on Contemporary Trends in Science and Technology Education. In this symposium, the President of EACT, Aarne Toldsepp, presented results from an international study on pre-conceptions in science and technology of 6th grade students, undertaken with the help of members of EACT and science educators in other countries.

This symposium recognised the need for the existence of ICASE as an umbrella organisation linking science and technology professional associations. All the Baltic countries—Estonia, Latvia and Lithuania have similar historical and cultural characteristics. During the symposium, the differences in the level of science and technology education development work was noted in the different countries. For faster development, it was agreed that greater coordination and cooperation was needed.

At the end of the 1995, representatives from EACT, together with the ICASE Executive Secretary, visited the Chemistry Teachers Associations in Latvia and Lithuania. The purpose of the visits was to hold initial discussions on possibilities for future cooperation and to fix when this could occur. Both associations subsequently joined ICASE. In addition, during a visit to Saint Petersburg, a Russian Chemistry Teachers organisation and a Russian Association of Chemical Pedagogical Education were established and agreed to support and promote Project 2000+ ideas and become ICASE members.

In teacher seminars given during the visits, exemplars that help to promote scientific and technological literacy were introduced by the ICASE Executive Secretary and the Estonian experience on how to use them in teaching was shared. The officials of the teacher associations were introduced to the idea of running writing workshops to help teachers appreciate the new direction and gain useful teaching materials. The proposed ICASE writing workshop for Eastern
European countries was explained. All organisations saw the urgent need for that and promised to start planning their participation.

**Annual Meeting of Chemistry Teachers, 26-27th January 1996**

The annual meeting, held in Secondary School number 14, Tartu, attracted about 100 participants. Five invited guests were present—the President of the Latvian Chemistry Teachers Association (Asis Buiva); the Vice President of the Lithuanian Chemistry Teachers Association (Salvinija Sleziene), the Secretary of the Russian Association of Chemical Pedagogical Education (Andei Zhegin), Attila Villanyi from the Executive Committee of the Hungarian Chemistry Teachers Section of the Hungarian Chemical Society and Onno de Jong from the University of Utrecht, the Netherlands.

This meeting concentrated on providing teacher help in two areas of the curriculum by means of an in-service course and in discussing the following:

- an overview of the present situation and perspectives of the work of different teachers associations,
- to identify ways for international cooperation between teacher associations
- to determine the role of the teachers associations in in-service provision and in curriculum development
- to determine ways to help teachers obtain useful teaching materials

Dr Onno de Jong ran the in-service courses on:
- “Teaching and Learning Chemical Calculations, Difficulties and Remedies”
- “Teaching and Learning Electrochemical Cells: Problems and Solutions”

Both topics are difficult for students and there is a urgent need to improve the teaching approaches in these areas. It was suggested that a more student-centred approach, taking into account the students individual development and abilities, was needed. Also needed was for teachers to change their teaching style from the direct transmission of knowledge to a style of facilitating a process of knowledge development. This needs to offer students the opportunity to work together in small groups, to develop their own problem solving methods, to stimulate students to analyse problems and to plan solutions extensively. Dr. Onno de Jong suggested the teachers themselves should develop the materials.

All participants received certificates to indicate they had passed the in-service course and became qualified to supervise others in dealing with questions on this part of the curricula.

**Need to Provide Non-Governmental In-service Training**

Of special interest were the discussions held on the role of non-governmental in-service training. As governmental in-service provisions offered mainly subject orientated courses, the teachers personal teaching skills, knowledge and information on what is happening in the rest of the world were neglected. To guide the EACT in meeting teacher needs in the future, a questionnaire was given to the participants. The findings will be taken into account in planning future courses. Teachers indicated they needed help in both subject updating and developing their teaching skills and hence suggested in-service training should be balanced and cover both areas.

Teachers indicated they were interested in getting more information about the different educational systems in the world, about topics in science that were very topical at this time and in how to promote scientific and technological literacy (STL). As there is lack of teaching materials, the teachers should be able to create it themselves. For that the special in-service courses are needed.

Discussion followed on a writing workshop planned by ICASE, in conjunction with EACT, for Eastern European Countries in May 1996. The workshop is intended to guide participants in writing supplementary teaching materials for use by teachers in teaching science subjects.

After the workshop the participants should take the responsibility to share their experiences within the associations and encourage others to be interested in follow up activities at a national level. It was suggested that the teacher associations should play a major role in ensuring this follow up and the production and distribution of the developed teaching materials.

The meeting welcome the writing workshop idea.

**Contract Between the Baltic Countries**

Cooperation in many fields of Education had been an old tradition between Latvia, Lithuania and Estonia during Soviet times. At that time the teachers ran yearly summer courses in the different countries.

At this meeting contact was re-established as signified by the presence of the Presidents of EACT and the Latvian CTA and the Vice-president of the Lithuanian CTA. During the meeting an Agreement was signed to re-establish cooperation between the Baltic Countries. To continue this cooperation an agreement was specified as follows:
1. To carry out joint Projects supporting Project 2000+ ideas.
2. To exchange, on a regular basis, curriculum materials, textbooks and all types of teaching materials.
3. To invite, every year, two to three representatives from the other associations to participate in annual meetings.
4. To run yearly in-service courses in different countries each summer, lasting for four to five days. The number of participants from each country is agreed to be 15. The host country is to be responsible for the accommodation and the planning of the programme, which should include activities for the participants. The participants are to receive certificates.
5. The final details of contract and research projects are to be fixed in May 1996.

The first summer seminar will be held in Vilnius in the summer of 1996. Representatives from the other teachers associations will be welcome. The working languages will be English and Russian.

(Left to right) A. Arne Töoldsepp, Estonian Association chairman; Salvinija Sleziene, Lithuanian Association vice president; Ansis Buiva, Estonian president; (standing) Miaa Rannikmäe, secretary EACT; Andrei Zhegin, Latvian Association president
THE PUPIL RESEARCHER INITIATIVE
BRINGING CUTTING EDGE SCIENCE TO THE CLASSROOM

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The Pupil Researcher Initiative (PRI) is an exciting and innovative science curriculum development project in the U.K. funded by two of the major government Research Councils: the Engineering and Physical Sciences Research Council and the Particle Physics and Astronomy Research Council, for an initial period of three years until September 1997. The Initiative is coordinated by Sheffield Hallam University.

The main aims of the Initiative are to provide resources, activities, strategies and support within curriculum time for science teachers and their pupils, so that the pupils, specifically aged 14 to 16 years will experience the excitement and relevance of science and engineering research, and so develop a lasting interest and enthusiasm.

To achieve these aims, the Initiative has developed several components, some of which are outlined below.

Thirty Pupil Research Briefs (PRBs) have been written by an experienced team of teacher writers, working in collaboration with researchers from a wide range of research establishments, including universities, research councils and industry, so that wherever possible, they reflect frontier developments in science and engineering. By setting a variety of realistic contexts, each PRB reflects the development stages of a real research project, so that pupils may be motivated by the experience of working in the way that real scientists and engineers carry out their research work. PRBs are particularly useful within the experimental and investigative areas of the science curriculum and they frequently provide ideas for various applications of IT, including monitoring, designing and using spreadsheets and databases, word processing and desktop publishing.

Figure 1 shows the general model for the PRBs using the Catalysis PRB as an example.

A selection of PRBs with a number of interactive databases, designed by science and engineering researchers on the Internet, will allow schools to pool their results electronically.

Pupils may also communicate their results by submitting an article to the PRI Journal, PRISM based on PRB work or indeed on any other interesting aspect of science that they wish. PRISM is circulated to every secondary school in the U.K., to contributory schools outside of the U.K., as well as to many research establishments. Contributions to the December issue are requested by the end of October.

Students studying for their doctorate in the sciences or engineering have also been involved, in the Researcher in Residence component of the Initiative. During a short placement in a school, the students act as positive role models offering advice on scientific concepts and processes which is particularly useful to pupils in developing their investigative and communication skills. The teachers gain from the support from qualified scientists in the classroom and from the opportunity to discuss further links with the research establishment. The students, themselves also gain from the insight into current education practices and from the chance to develop their own communication skills with a non-specialised group. They have often extended their liaison with the school to support extracurricular activities such as helping to run a Science Club or a Science Fair, organising residential field work and visits to the research department. During the first year, evaluation from more than 500 student and school participants in this part of the Initiative has been especially positive, and we hope to place an equal number of students in schools in this final year.

Schools are also encouraged to communicate their results from work based on PRBs, with Researchers in Residence, or indeed any other stimulating aspect of scientific work by running their own Science Fairs, for which they receive support from PRI. The number of Science Fairs is continuously growing, and we are very encouraged by the enthusiasm of the participating pupils and the quality of the work. We are hoping that more
schools will also wish to communicate their scientific achievements to a wider audience, in this way.

PRI has produced a comprehensive resource booklet for schools on Science Fairs in conjunction with the British Association for the Advancement of Science, and we would be most interested to exchange ideas on Science Fairs in general with the readership of Science Education International.

On a larger scale, PRI has recently run a series of regional Conferences, across the U.K., giving pupils the opportunity to present their own science and engineering research to real scientists, during informal discussion settings. The Conferences are run on the same lines as a proper scientific conference but with the pupils taking the leading role and presenting their research work as visual, interactive workshops to audiences of professional scientists, the media and other pupils. Pupils are most enthusiastic to take on the role of researchers and have presented work on a huge variety of topics including meteor activity, concrete and the chemical industry, coral reef bleaching, the appliance of science in the design of lifts, the ripening and picking times of cider apples for a commercial producer. Evaluation on the Conferences has been extremely encouraging from all participants including teachers, pupils, scientists, science advisers and professional representatives, so we are planning to run a national event in March 1997 as part of National Science Week (SET '97), when pupil delegates from outside of the U.K. will be invited to attend.

From the above components plus others, PRI is confident in achieving its original aims: above all, the success of this project will be judged by the pupils’ enthusiasm for science and the quality of their learning.

Further information on any aspect of PRI may also be obtained from:

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Figure 1. Outline of Catalytic Traps PRB

Context setting: Research Council Press release calling for research project proposals in Catalysis.

Background knowledge: Pupils, as researchers, work through two short papers produced by a research group meeting.

Paper 1 describes the background science to Catalysis, continuous flow fermenters, and possible future projects.

Paper 2 provides a description of the continuous flow fermenters using immobilised enzymes and Alginate beads.

Investigation: Pupils use their knowledge gained from Papers 1 and 2 to begin to plan and carry out an investigation into the feasibility of developing a continuous flow reactor which uses immobilised inorganic catalysts.

Communication: Pupils produce a feasibility report which will inform the decision of the research group when they develop research proposal to the Research Council.
AN EXPERIMENT WITH SOAPY WATER


Challenge:
What Happens When You “Pop” a Soap Film.

You Need:
— A piece of flexible wire about 40cm long. Any available piece will do, but wire of 0.6 to 1mm diameter will work best.
— A piece of string, and a piece of cottedng thread.

Instructions:
1. Bend the wire and make a frame as shown in the sketch.
2. Next, take some cottedng thread and make a loop. The loop should be small enough to fit in the frame.
3. Tie a piece of string at two opposite points on the loop; attach each loose end onto the wire frame. Make sure the string is not tight but loose.
4. Prepare some soapy water. You need enough to immerse the wire frame into. Immerse the frame in the soapy water and then gently lift out. A thin film of soapy water will form inside the frame.
5. Take a pencil and pop the part of the frame that has formed inside the loop of cottedng thread.
6. The part of the film which has popped will form a nice circle. Even if the attached strings are shaken the loop will always return to the shape of a circle when released.

Notes to the Teacher
The purpose of the experiment is to observe what shape the loop will take at this stage. It illustrates how a film of soap is pulling from all sides shaping the loop into a circle. This is an example of surface tension and the pupils will see practical proof of the fact that among all possible shapes that can be formed out of a given circumference, the circle will take the greatest surface area.

Reference:
The stepping into science project newsletter, Spring 1996, Volume 5, No. 1.
A NEW INTEGRATED INSERVICE COURSE
FOR SCIENCE TEACHERS:
BACKGROUNDs AND EXPERIENCES

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The Need for a Professional Development of Science Teachers

In many European countries during the last decade, science teacher education has changed rapidly. Although developments differ from country to country, some are shared. One of the most interesting common trends concerns a growing interest in inservice courses for science teachers. This trend is triggered by a number of diverging factors. The main factors can be summarized as follows.

Firstly, the implementation of new science curriculum topics or even a whole new curriculum for science (e.g. in the UK). These changes require the 'updating' of teachers' knowledge and skills, especially in the case of the introduction of new educational technologies, e.g. computer assisted instruction.

Secondly, the rise of new ideas about teaching and learning science, such as the constructivist points of view regarding knowledge acquisition. According to this perspective (see e.g. Driver, 1989; Osborne and Wittrock, 1983), learning is a dynamic and social process in which learners actively construct meaning from their actual experiences in connection with their prior understandings and the social setting. A major implication for teaching is the idea that science teachers should have insight into students' (pre)conceptions of science topics and should facilitate learning by creating conditions enabling conceptual change.

Finally, dissatisfaction with existing ways of science teacher training. For example, many inservice courses primarily consist of a direct transfer of knowledge and skills. However, this 'top-down' approach excludes an active participation of teachers and, moreover, many courses do not link up well with (practical) needs of teachers. Therefore, effects of this type of teacher training are often felt to be rather disappointing (OECD, 1981).

In sum, in line with the trend of paying attention to the professional development of science teachers, a need to improve the quality of inservice courses is necessary.

New Aims of Science Teacher Training

In this article, an improved science teacher inservice training program is reported. This training was developed as part of a Dutch research and development project, initiated by the Chemical Education Department of the Centre of Science and Mathematics Education at Utrecht University. The newly designed inservice training can be characterized as a practice-oriented course on a constructivist foundation. The basic aims are:

a) To help teachers to connect (classroom) practice with (course) theory. This aim implies that training activities will not only be carried out during meetings of participating teachers, but also during and after lessons at school.

b) To stimulate teachers to become (more) aware of their own teaching beliefs and classroom practices. This aim implies that a lot of attention will be given to reflection on own conceptions and actions.

c) To encourage teachers to change their conceptions of science teaching and to reconstruct their teaching activities. This aim implies that learning conditions will be created which give teachers the opportunity
to participate in an active way and to explore new teaching ideas and actions.

During the last few years, our Chemical Education Department has worked with several groups of chemistry teachers in the context of teacher training. In all cases, a training programme was developed which integrates elements of classroom practice, course theory, teacher reflection and conceptual change. The key features of the design of such an integrated training programme are described in the next section.

Design of the Integrated Inservice Course

The first part of the course consisted of two or three meetings of the participants. During the first session, the teachers exchanged ideas and experiences regarding (difficulties concerning) their current teaching practice. During the next session(s), they discussed a new course in a particular chemistry topic. The course materials were based on a constructivist point of view and consisted of a self-instruction package for students and an accompanying teacher guide. The teachers had to carry out the main students’ tasks which were described in the student package.

The second part of the training programme was mainly carried out at school. All teachers gave their students a copy of the packages and told them to work in small independent groups, mostly pairs. Each group was supposed to produce its own written answers. All the tasks (experiments, questions and so on) required the students of the same group to go on discussing until consensus was reached. At the end of each lesson, the teacher received a copy of the written answers of the groups. Only those answers were accepted which had been developed without any help of the teacher or premature comparison with final booklet answers. Each teacher analysed the answers and used the results to reflect on old and new teaching strategies.

During the lessons period some additional meetings were organized. During these meetings the teachers presented the results of their analyses. Together, by means of subsequent discussions, they reflected on their teaching beliefs and practices.

The final part of the course consisted of two or three meetings involving an evaluation of personal learning processes as well as a course evaluation. The last mentioned activity was focused on the in-service course itself as well as on the students’ course, especially on the materials used.

Investigations

It is not only important to develop new teacher training, but also to investigate the course impact on teachers. During the last few years, our research has focused on several new courses for chemistry teachers.

The courses under consideration were:

1. A course in teaching methods for solving proportion problems within a science context, e.g. problems involving the concept of concentration (De Jong, 1995). Nine experienced teachers were involved in this course.
2. A course in teaching the concept of mole and stoichiometry (De Jong, 1990). In this course, 12 experienced teachers participated.
3. A course in teaching the topic of electrochemistry (Acomo and De Jong, 1994). A new group of nine experienced teachers were involved.

The research focused on teachers’ learning processes in changing teaching conceptions and in reconstructing teaching activities. The main research data were obtained from classroom observations and audiotaped discussions in training meetings. In addition, written students’ answers concerning classroom tasks were collected and analysed.

Main Teachers’ Learning Outcomes

When the three courses mentioned before are considered together, the main teachers’ learning outcomes can be summarized as follows.

a) Better knowledge of students’ (pre)conceptions and methods of problem solving. For example, the teachers appeared to have learned a lot about ‘alternative’ conceptions of students. They became more conscious that their knowledge of these conceptions was inadequate. Frequently they had been astonished when faced with results after analyzing students’ written answers and discovering the great variety of methods used by the students. In addition, they became aware that sometimes there is a discrepancy between their prescribed methods and effective methods of students.

b) More competence in talking less and listening more carefully to students. For example, the teachers appeared to be more perceptive of students’ oral and written statements. The teachers reported to introduce new chemistry concepts more carefully and to be more considerate of students’ methods of problem solving. They acknowledged that this approach implies an important change of their usual teaching strategy.

c) Growing awareness of their own conceptions of teaching and learning science. For example, on the one hand, the teachers were inclined to think that efficient learning is
realised when teachers try to transmit knowledge in a direct way. On the other hand, the teachers also believed that it was important for students to learn in an active way by observing and interpreting natural phenomena by themselves.

Final Comments
There is an increasing interest in teacher training founded on a constructivist perspective (Clark, 1986). The interest in stimulating teachers to reflect on their own classroom practices is also growing (see e.g. Baird et al., 1991). However, little is known about inservice courses which integrate elements of classroom practice, course theory, teacher reflection and conceptual change. In my opinion, because of the importance of the integrated teacher training, it is necessary to develop and investigate such courses more extensively. The results will contribute to improve science classroom practice as well as science teacher education.

References


IMPLEMENTING A SCIENCE EDUCATION FIELD EXPERIENCE

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This article describes our initial efforts to incorporate a science field experience for our upper division elementary education majors (fourth through sixth grades) into the teacher preparation program. For many readers, supervising students’ field experience may be rather routine. It was not for us. This narrative relates what we did, what worked, and what didn’t.

For many years, the science educators in our department have complained about the lack of science field experiences for our upper elementary students. While the students’ program included an extensive pre-student teaching field experience, this practicum centered on language arts and reading. Any science, social studies or mathematics lessons that the students may have prepared and taught were entirely incidental. We argued with our reading and languages arts colleagues about the value of a field experience that did not reflect the breadth of the elementary school curriculum. This past semester, however, we learned anew the relevance of the old adage, “Be careful for what you wish for, it may come true.”

It was decided that one third of the students’ time in the schools, two hours a day for four weeks, would be devoted to science and social studies instruction. From the very beginning, implementing this practicum for 20 students was akin to sailing a ship while it was still under construction.

The first task was to find area elementary teachers who would take our students from 9:00 to 11:00 a.m. during the month of September. This proved to be more difficult than we had anticipated. Our university is located in a rural region with a low population density. We were competing for teachers with the student teaching program and the language arts and reading practicum. Additionally, few self-contained classroom teachers taught science and social studies during the morning (that time period was reserved for the “really important stuff,” reading and language arts). To find enough teachers, it was necessary to place some of our students 30 miles from campus and to double-up several students with one teacher. After some scrambling, we were able to find classrooms for all of the students. However, that was not the end to our problems.

From some students we heard, “How can I get out of one class at 8:50, drive 45 minutes and be at school ready to teach at 9:00?” and there were the concerns of the corresponding group, “How can I leave school at 11:00, drive 45 minutes and make my 11:00 class?” There were anxious commuters who didn’t want to drive to campus and then turn around and drive out to the schools. There were also nervous student-parents who needed to get their children to or from day care. It became apparent that organizing a canoe trip up the Amazon during the rainy season would be easier than coordinating the students’ schedules! Eventually, however, the major transportation problems were resolved. We were ready to move on to the next crisis.

With only one month to work, we wanted the students to be as prepared as possible for their first week in the schools. A letter was sent to the participating teachers asking what science and social studies topics they would be covering. This seemed like a logical thing to do, but was not particularly helpful. The teachers’ responses ranged from wide open (“Whatever”), to vague (“Something about space”) and, finally, to the noncommittal (“I won’t know until I get there”). Having the students personally call on the teachers was somewhat more useful, but several of the teachers complained that being contacted by the students was a bother. In the end, our efforts at advanced preparation were negligible and most of our students began their experience in the schools without a clear sense of their teachers’ expectations.

Once in the classrooms, the students quickly learned that the scope and quality of their field experience would be determined, not by their college instructors, but by their supervising teachers. Most of the students were welcomed by their teachers and soon felt like members of the school community. Unfortunately, other students sat in the back of their teacher’s classroom, seemingly unnoticed. Students who worked with a single teacher, in a self-contained classroom, fared better than those in departmentalized situations. The departmental programs’ rigid schedules and constant class changes made it difficult for our students to get to know and interact with either the teachers or the students. Several departmental teachers’ perceived need to “keep all their classes together” placed additional pressure on our students to mimic the teachers’ managerial and instructional practices.

Our field experience, like most, was intended to provide our students with a “real world” context in
which to apply what they had learned in their college classrooms. Not surprisingly, much of what our students saw in their classrooms was at odds with what they had learned in their methods courses. While we stress active hands-on learning in science and social studies, most of what the students saw was traditional text-driven instruction. Their journals reflected their observations and their frustrations.

I have observed that both teachers to very much by the book. The lessons are designed mainly by what the book says. I feel it is important to do different activities instead of reading the book, doing the questions, filling out a worksheet, and taking a test. Science has so many activities and experiments that help the student become excited about learning—instead it’s the same thing day after day.

The students also observed teacher behaviors that did not fit their preconceptions of how teachers should interact with their students.

I’m disappointed in what I am seeing. She is supposed to be our role model and she is displaying teaching methods which we have been warned not to practice. It’s going to be hard to motivate children who are scared and not even respected by their teacher.

As one student wrote, reflecting back on his experience, “I can’t say that observing my teachers was all that valuable. Overall I learned a lot about what I will not do.”

Once the students were in the classrooms, our job was to help them prepare their lessons and to evaluate their instruction. We quickly learned how challenging these tasks were to be. Finding time when both we and the students were free to meet was the first major obstacle. During the mornings, we were on the road observing students and they were in the classrooms being observed. During the rest of the day, both the students and ourselves had other courses to tackle. Office hours became an abstract concept, as were literally “on call” whenever and wherever students might find us. In addition, we faced the same transportation issues as our students. We often spent more time in the car than we did in the schools. Despite our efforts to coordinate our visits with their teaching, we now and then missed connections. It was not unusual to arrive at school only to find out that a test, school pictures, or an assembly had been scheduled. Our students experienced similar frustrations when we occasionally failed to make it to their classroom. As one student lamented, “Where were you yesterday? My lesson was awesome and you missed it!”

While we had expected our efforts would be invested in observing and helping the students with their lessons, we did not anticipate the time we put into counseling. After being in the profession for 25 years, we tend to forget how significant these early teaching experiences are to students as they confront both their hopes and their fears. Not surprisingly, many students had bad days. In those cases, we were there to help them put these experiences in the proper perspective and to move on. Several students expressed serious doubts about whether teaching was right for them. Perhaps it’s not, but it was crucial that we be there to assist them in making realistic appraisals of their performances in the classroom.

At the end of the four weeks, we met individually with each student for an exit interview. We reviewed their required paperwork, their teacher’s comments, and our observations and evaluations. The students’ journals proved to be one of the most important evaluation tools. Their own thoughts provided important insight into the value of the field experience. After the ups and downs of our experience, it was gratifying to read such comments as, “I loved going into the schools and working with my teacher. The kids were wonderful. This course was very valuable to me.” The students’ journals and our final interview proved to be much more meaningful, to the students and to us, than the “Satisfactory” or “Unsatisfactory” they would receive on their grade report.

As a result of our experience, and that of the colleagues who followed us, we have taken steps to refine the field experience. Some of these changes include:

- Moving the field experience to the end of the semester to allow students more time to meet with their supervising teachers and to coordinate and prepare their lessons;
- Arrange the course times so that students can meet with their supervising teachers either before or after school;
- Provide supervising teachers with more specific information as to our expectations for them and for our students;
- Screen potential supervising teachers so as to provide positive rather than negative models for our students; and
- Coordinate the supervisors’ transportation schedules to maximize observation time.

In retrospect, the most important lesson we learned was that flexibility must be demonstrated by supervising teachers, students, and, of course, the university instructors if a field experience is to be successful. While advanced planning may be crucial, it is only as useful as reality allows it to be.
SCIENCE CENTRES AND WORLD WIDE WEB: THE INTERACTIVE
CHALLENGE
Reprinted from the
3rd INTERNATIONAL INTERACTIVE MULTIMEDIA SYMPOSIUM
Proceedings

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Abstract
Questacon—The National Science and Technology Centre is one of several interactive science centres around the world using World Wide Web as a strategy to provide virtual tours of their exhibitions and information about their programs. Some centres, including Questacon, are developing web sites with a difference—after all, they are centres which encourage hands-on approaches and as much interaction as possible. This paper will explore ways in which centres like Questacon are developing interactive approaches on the web.

A question of interactivity
More and more science centres around the world are issuing an invitation for people of all ages to enter the fascinating world of science and technology through their computer. Science centres are discovering that the Internet—in particular, World Wide Web—provides a rapidly escalating opportunity to reach a wider audience, thereby promoting a greater public understanding and appreciation of science and technology and their impact on our everyday lives.

The capacity of web browsing software to integrate text, images and sounds has attracted many science centres to the idea of establishing a presence on the Internet. However, those science centres which emphasise hands-on, interactive experiences, are looking forward to developments in web browsing software which will achieve far greater ‘interactivity’ in contrast to the more passive, page-turning experiences that today’s web users are familiar with. Such developments may then provide an experience which is genuinely interactive, where users encounter science phenomena in engaging ways, manipulating devices and data to test and develop their understanding.

The interactive approach
During the 1980s, interactive approaches to learning began to attract more widespread attention among education researchers and teachers. An interactive approach to learning science, according to one group of science education researchers (Biddulph et al., 1986), has an emphasis on ‘identifying learners’ present ideas and interacting with them to help them to modify or extend their ideas . . . nudging their thinking as far as possible to enable them to make better sense of their world.

At the same time, the rapid growth of science centres produced an additional community of science communicators and educators developing exhibition and program experiences also defined as ‘interactive’. When visitors interact with hands-on exhibits and activities in science centres, they are able to test their understanding of ideas as they interact with phenomena and with each other.

When the physicist Frank Oppenheimer founded the Exploratorium in San Francisco, he felt concerned that people were becoming information rich and experience poor. He wrote (Oppenheimer, 1968): ‘On the whole, people have very little opportunity to have any direct experience with the separate elements of nature or technology. They watch ocean waves, but have never been shown how to observe the way waves
pass through each other, bend around corners or bounce off cliffs. In a science museum, one can provide these direct experiences with the behaviour of light, sound and motion. One can set up these experiences in such a way that they not only generate, but partially satisfy curiosity. Science is not just a process of discovering and recording natural phenomena; it is a process which develops our ways of thinking about nature and which enables us to find the connections that simplify and at times enrich our comprehension and awareness of nature.*

Designing for diversity

Visitors to science centres bring with them great diversity in terms of their previous knowledge and experience, their assumptions and their expectations, as well as their ways of thinking and learning. Science centres expect this diversity and design their exhibits and programs accordingly—as open-ended opportunities which provide flexibility in the manner and level of investigations individuals and groups may wish to undertake. Some visitors will want to explore a phenomena in depth—and may find out things which were never intended by the designer! Others will spend only a few seconds with an activity before proceeding to another—rushing to experience as many activities as possible (albeit superficially) in the time they have.

Feher (1990), in an article about the role of interactive science museums in studying how people learn, refers to an excerpt from a Grade 4 textbook which states 'Light is energy that you can see. Light travels through space in the form of waves.' She goes on to relate how statements like this are abstract and uninteresting because ‘...there is nothing you can do with it. There’s nothing to go home and try out. There’s no experience of nature. The problem is endemic in our schools: teachers teach abstractions, definitions and explanations of phenomena that, for the most part, students have never explored, or, worse still, that students may not even know actually occur. If schools so often put the cart (explanations) before the horse (first-hand experience of natural phenomena), modern science museums reverse the process. Science centres ‘...present natural phenomena in the form of exhibits that are interactive and manipulable, exhibits whose express purpose is to enable visitors to explore and experiment’.

Visitors to science centres have an opportunity to test their understanding as they interact with science phenomena through exhibits and activities—the more compelling the experiences, the more likely learners will develop their understanding of the phenomena.

A recent article in American Scientist describes how many science centres are now delivering hands-on experiences direct to the school or home via the Web. ‘Although some of the science centre Web sites lack any useful information beyond museum hours, location and so on, many of them offer enriching experiences, almost like making a real, rather than a virtual, visit.’ (May, 1995)

Questacon’s Web site

Questacon—The National Science and Technology Centre was established in Canberra, Australia in 1988 to promote understanding and appreciation of science and technology. Through its interactive exhibitions and an array of public and school programs, the Centre has become one of the major science centres in the world. Each year, over 350 thousand people visit the Centre in Canberra, and more than a million people are reached through Questacon outreach programs. Questacon is active in touring exhibitions and conducting programs beyond Australia, particularly in the Asia-Pacific region.

In May 1995, Questacon launched its World Wide Web site. Here you can take a virtual tour of Questacon’s six galleries to see some of our hands-on exhibits, find out how to organise a group visit and obtain information about the Centre’s programs for schools and the general public across Australia. Many web sites provide information like this, but Questacon has been developing a site with a difference—after all, Questacon is a centre which encourages hands-on approaches and as much interaction as possible! Hence, you will find much more than information on the Questacon Web site. On a rainy Saturday afternoon at home, or to liven up the school classroom, have some fun and learn at the same time by trying some of the hands-on activities on Questacon’s web site. The activities use readily available materials and provide plenty of fascination for all ages. Practice your problem solving skills in Puzzleguest. Try an intriguing experiment, and explain how it works. Questacon’s Web site can be located at http://sunsite.anu.edu.au/Questacon.

Hands-on science centres worldwide

A useful place to begin your search for science centres and the various programs they are establishing on the Web is a directory of hands-on science centres worldwide, located at http://www.cs.cmu.edu/~mwm/sci.html

The future

With the arrival of Java, a new programming language developed by Sun Microsystems, and similar software development initiatives, the web will feature considerably increased levels of interactivity. Java, for instance, is designed to interact with the user, providing not only the text, images and sound that current users
are familiar with, but also software ‘exhibits’ or ‘lab benches’ on which experiments can be set up and simulated, regardless of the user’s computer operating system. With Java’s multi-threading feature, we can look forward to better interactive responsiveness and real-time behaviour—at least to the level that the underlying computer operating system will permit.

Questacon is currently developing some trial activities utilising features of the new version of Netscape 2.0 incorporating Java. These activities provide a much higher level of interactivity—users can manipulate objects in order to experience and explore scientific phenomena.

Editors Comment

Technologies such as World Wide Web offer many educational opportunities. Please let us know how these tools are being developed in your country.

References


About the author

After 20 years as a science educator and administrator in schools, Brenton Honeyman joined Questacon—The National Science and Technology Centre in Canberra, Australia, as Manager of Education & School Programs. Brenton and his team coordinate a wide range of public and school programs across Australia, focusing on interactive approaches to learning and experiencing science and technology as they relate to our everyday lives.

Brenton’s career as a science educator includes a diverse range of positions and appointments, including President of the Australian Science Teachers Association; Convenor of the World Conference on Science Education and the Quality of Life; and Editor of Science Education International. He is currently the President of the International Council of Associations for Science Education (ICASE) and is working with UNESCO and other international organisations on worldwide projects to enhance scientific and technological literacy for all.

His current interests include broadening teaching learning repertoires so as to increase student engagement in learning, science communication, international science education, and educational uses of electronic and information technologies.

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Book Reviews

TOWARDS MORE EFFECTIVE SCIENCE TEACHER DEVELOPMENT IN SOUTHERN AFRICA

Leo de Feiter, Hans Vonk, Jan van den Akker, Vrije Universiteit
Amsterdam, The Netherlands

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From the outset it needs to be pointed out that this is more than a book describing science education in Southern Africa. As the authors point out in the introduction, it is the result of a literature review and presents an exploration of the current state of affairs regarding science education (certainly in the three Southern Africa countries of Botswana, Lesotho and Swaziland) and of literature relevant to in-service teacher education activities.

The book is the product of cooperation and discussions between specialists in the field of in-service education through links between the universities of Southern Africa and the Vrije Universiteit Amsterdam. A major problem experienced in the early 1990s with regard to in-service science teacher education projects was how to design interventions for optimal effect and how to establish their effectiveness. This book explores efforts made in this regard and their links with the research findings put forward in the literature.

This is a very readable book that gives a very clear insight to the educational system in Botswana, Lesotho and Swaziland and the in-service professional development programmes for science teaching. Chapter 2 looks at some of the major factors characterizing science education in secondary schools in the three countries and based on this, leads to implications for science teacher development. In so doing international developments are considered and the trends in curriculum development towards science for all and more societal interaction are included.

From an ICASE point of view it is disappointing that scientific and technological literacy is not mentioned as an important goal for science education. The review of the literature did not extend to the ICASE, nor the UNESCO, publications which are rich in this area. This raises the dilemma for ICASE—should it put more efforts in putting forward articles in research journals, or is it more appropriate to emphasize the message to teachers. It would seem, judging by this book, that ICASE is not achieving either of these goals at present.

Chapters 3 and 4 of this book are excellent reading for all science educators. Chapter 3 expands on effective science teaching and covers constructivism, the notion of 'less is more' and in a simple and easily read manner, what research says about effective science teaching. Chapter 4 considers effective science teacher development. It points out that governments have begun to regard teachers as key persons in the process of educational change. This is at the very heart of STA development and the rationale for the existence of ICASE. It is not surprising, therefore, that the book elaborates on the concept of teacher professional development and areas such as individual development, school-based teacher development and teacher development activities at the national level. The book concludes with a reform strategy based on an adaptation of the Vespero’s stage model illustrating the types of intervention possible depending, among other things, on the teacher background, professionalism and reaction to innovation. Missing is the role of the science teacher association. With much attention placed on the professionalism of teachers, this is really surprising. It perhaps illustrates the difficulty in developing a self based development strategy when teacher motivation and confidence are low and where efforts to organize help groups are thwarted by obstacles. Nevertheless teacher associations do exist in each of these countries and they are sufficiently active to have a place in the teacher development equation.

In conclusion this is a book to be recommended to all science educators and especially to all teachers in Botswana, Lesotho and Swaziland. The illustration of the approaches to science teaching and science teacher development should be of great interest. Although ICASE’s promotion of scientific and technological literacy as the main rationale for the teaching of science is missing, many attributes that lead to this are clearly described. If science teaching and teacher preparation could develop along the lines advocated in this book, many of the ICASE goals would be fulfilled.
SCIENCE/TECHNOLOGY/SOCIETY AS REFORM IN SCIENCE
EDUCATION

Editor Robert E Yager, Science Education Center, University of Iowa, Iowa City 52242 USA

State University of New York Press, State University Plaza, Albany, New York
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Here is a compilation of articles on the STS (science—technology—society) movement presented in five parts—STS as a Reform Movement in Science Education; What an STS Approach can Accomplish; What the STS Approach Demands; STS Initiatives Outside the United States; Supporting the STS Reform. The book is 337 pages long with 29 chapters. The first two parts represent Yager's thinking and much of the early chapters are either written by him or his former students. These chapters compile much of Yager's writings in the literature on the STS movement.

Without doubt this is an important publication covering the rationale, the research base, as well as the teaching strategies that are related to STS as a reform movement. The evidence for this approach, as expounded in Chapter 2 is overwhelming whether it is mastery of basic concepts, process skills enhancement, promoting the affective domain, creativity or application of learning. By the substitution of STS with STL (scientific and technological literacy), the book reinforces the philosophy of Project 2000+, as initiated by UNESCO and ICASE.

The book reminds us that STS is an American initiative and that there have been many attempts to initiate STS programs into secondary schools. However it points out the term STS was coined by John Ziman in his book Teaching and Learning about Science and Society (1981), published in Britain. Section 4 illustrates STS initiatives outside the United States. STS is seen as a response to many of the perceived problems of traditional science teaching—students cannot use the science they learn; most students not to attain functional scientific literacy; lack of interest in science and the diminution of creativity skills even though these are central to basic science. Above all STS, is seen as a means to attain the educational goals often overlooked in traditional teaching, because the content becomes the sole focus of teaching.

This book suggests that the more able students will receive a more challenging, all round education if exposed to the STS ideas, surely a factor of great importance for science education. But if cognitive gains are not measurably greater through STS teaching, certainly higher achievement is illustrated for creativity, problem solving and self motivation. STS also enhances the opportunities for low ability students. In fact a whole chapter is devoted to exploring the value of STS for less successful students in giving them the confidence to play a more active role through working at their own pace. Teachers must surely welcome this. With education for all and the need for all students to study science education comes the need to provide an appropriate and motivational education for the average and less able student, as well as the much smaller in number, more able students.

The book is excellent. The message is clear. The text is very readable and easy to follow. Many examples are given and surely every teacher can find something that is useful and can guide them along the STS approach. Science needs to be taught in an approach put forward in this book. What is the problem?

The first problem is that most teachers will not read this book. For many US$20 is too high a price to pay and anyhow where does the foreign exchange come from? Making it available in science education libraries is important but how do teachers gain access to these? It is clear that science teacher associations need to do more to bring the message of the book to science teachers. ICASE is undertaking the first stage by making STAs aware of its existence through this review. ICASE continues to promote Project 2000+ and the need to take steps at the national level for scientific and technological literacy.

The second and more serious problem is that even if teachers know that the STS (STL) approach is important, still they fail to change their practice, often citing 'must finish the syllabus', 'don't have resource materials', 'it is not as given in the textbook', 'must teach for the examination', etc. What this shows is that teachers do not really understand the STS or the STL movement. They fail to grasp that at the heart of the problem is the teacher, the teacher background and the manner in which the teacher views education. Even though the evidence in the book is overwhelming, teachers continue to believe they must be the centre of classroom action and the fountain of knowledge for
students. Even though teachers will agree with the message in the book that students do the learning (not teachers), they still say the teacher must finish the syllabus, rather than the teacher must help the students to learn through interacting with the syllabus. The book cannot help to put the ideas into practice - here is the importance of the science teacher association. Thus the importance of the book is indicated by the value placed on the ideas contained by the science teacher association. If the association endorses the research findings and the practices being expounded, and is willing to promote them to teachers, then the book may stand a chance of succeeding in its mission to promote a megatrend in science teacher education. Without that and it fails.

The endword in the book indicates that not only is there an increased need to understand large national issues, there is also an increasing need to understand the way science and technology affect us as individuals. It asks 'Can we shift our goals, programs and practices from the current overwhelming emphasis on academic preparation for science careers for a few students to an emphasis on preparing all students to grapple successfully with science and technology in their own, everyday lives, as well as to participate knowledgeably in the important science-related decisions countries will have to make in the future? This is certainly the challenge and this book does much to bring this challenge to our attention.

Science/Technology/Society as reform in science education is important. Its goals is scientific and technological literacy at an operational, structural and multifaceted level. This coincides with the goals of Project 2000+. The book provides an extremely useful guideline to the direction science teaching should take and the philosophy and research findings behind this. These aspects are clearly set out in very readable chapters. Thus the book is nothing less than crucial reading for all in science education reform. Reforming science education, ICASE hopes, applies to all science teacher associations.

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by

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British Council International Seminars

Science, Technology and Society: Education for Citizenship and Work (9649)
2 to 12 September 1996, Oxford—Fee: £1,590 (residential)
Directed by Dr. Joan Solomon of the Oxford University Department of Educational Studies

Science Education for the 21st Century: Policy and Practice (9676)
15 to 24 September 1996, Leeds—Fee: £1,490 (residential)
Directed by Professor Edgar Jenkins, Dr. J. F. Donnelly and Colin Wood-Robinson

Science Parks (9699)
1 to 12 September 1996, Sunderland—Fee: £1,740 (residential)
Directed by Professor Jeffrey R. Brown

For further information contact:
International Seminars
The British Council
1 Beaumont Place
Oxford O1 2PJ, UK
Telephone: +44(0)1865 316636—Fax: +44(0)1865 57368/516590
email: International.Seminars@britcoun.org

1997 Special Issue of Science Education (on Informal Science Education)
Editors: Lynn D. Dierking, Science Learning, Inc., and
Laura Martin, Arizona Science Center

Focus
This special issue will discuss perspectives on informal learning and present research findings documenting the role that experiences play in promoting people's science interest, knowledge, and supporting and reinforcing the science learning that occurs in schools.

Targeted Topics
1. Relationships between learning and the physical and social environments of many informal settings.
2. Applying theoretical learning strategies, such as constructivist learning theories and concept formation to informal settings, or developing theories specific to informal theories.
3. Defining and measuring informal learning, e.g. family learning in museums or the home.
4. Dynamics between informal and formal learning settings.
5. Play and curiosity as components of learning.
6. How the characteristics of informal settings influence behavior and learning.

Timeline
Manuscripts Due: November 1, 1996
Reviews Returned: February 1, 1997
Revisions Due: May 1, 1997

Manuscripts should run between 5 and 20 double-spaced, typed pages. Other information for contributors can be found on the last pages of Science Education. Diskette submissions are encouraged. Manuscripts must be submitted in quadruplicate (one original and three copies) to Kirsten Ellenbogen, Vanderbilt University, Peabody College, Box 506, Nashville, Tennessee 37203.

This will be a competitive, peer-reviewed process. Please contact the editors if you are interested in reviewing submissions for this special issue.

Inquiries concerning this special issue should be directed to: Lynn D. Dierking at (410) 268-5149 or by email to sli@internetmci.com or Laura Martin at (602) 257-1450 or by email to lmartin@pc2.pc.maricopa.edu.
2-5 July, 1996
World Congress on Engineering Educators and Industry Leaders, UNESCO, Paris

This congress is jointly organised by UNESCO, the United Nations Industrial Development Organisation (UNIDO), the International Union of Technical Associations and Organisation (UATI) and the World Federation of Engineering Organisations (WFEO)

All correspondence and inquiries concerning the Congress should be addressed to:
Secretariat of the Congress
UATI
Maison de l’UNESCO
1 rue Miollis
75732 Paris, France
Fax 3301043062927
email unispar@unesco.org

Inquiries regarding the conference should be directed to:
Gemma Friedlieb
Faculty of Education
University of Canberra
PO Box 1
Belconnen, ACT 2616, Australia
Tel 61-6-2012467
Fax 61-6-2015065
email gemmrf@education.canberra.edu.au

14-19 July, 1996
14th International Conference on Chemical Education

For further details please contact:
ICCE Conference Secretariat
Continuing Professional Education
The University of Queensland 4072, Australia

8-11 July, 1996
The 45th Annual conference of the Science Teachers’ Association of Australia will be held in Canberra.

The theme of this year’s CONASTA conference is ‘Keeping Science Afloat’ It aims to keep science high on the National Agenda while maintaining strong links with centre/classroom practice.

For details on CONASTA 45, please contact:
Convenor
CONASTA 45
PO Box 505
Curton, ACT 2605, Australia
Tel: 61-6-2816624
Fax: 61-6-2851336

22-26 July, 1996
EDINBURGH ‘96: The fourth International Conference on School and Popular Meteorological and Oceanographic Education

For further information:
Mr. J M Walker
Department of Maritime Studies
University of Wales
P.O. Box 907, Cardiff CF1 3YI, UK
Tel: +44-1222-874271, ext. 6754
Fax: +44-1222-874301
email: walkerjm@cardiff.ac.uk

11-14 July, 1996
The 27th Annual conference of the Australian Science Education Research Association

21-27 July, 1996
Second European Mathematical Congress

This congress will be held in Budapest, Hungary, hosted by the Janos Bolyai Mathematical Society. The Scientific Committee is chaired by Jurgen Moser, Germany, and the Organising Committee by Gyula Katona, Hungary
For further information contact:
Janos Bolyai Mathematical Society
Foutca 68
H-1027 Budapest
Hungary
e-mail h3341sz@ella.hu

For further information and details of how to present, contact:
DeWitt Stone
BCCE General Chair
Clemson University
206 Sikes Hall
Clemson, SC 29634-5170, USA
Fax 1-805-656-1515
e-mail bcce@chemson.edu

24-28 August, 1996
London International Youth Science Forum

For more information contact:
London International Youth Science Forum
PO Box 159
London SW10 9QX
United Kingdom
Tel: 0171 373 4568
Fax: 0171 385 1070

29 July—2 August, 1996
Junior Mathematical Congress-96

For further information please contact:
Peter Kortes
Department of Mathematics
University of Miskolc
H-3515 Miskolc-Egyetemvaros, Pf. 10
Hungary
e-mail matjun@gold.uni-miskolc.hu

30 July—3 August, 1996
16th Nordic LMKF conference

For more information, please contact:
Lisbeth Ekstrom
LMKF-Kongressen 1996
Gia Ledbergsvagen 6
S 58320 Linkoping
Sweden

4-8 August, 1996
14th Biennial Conference on Chemical Education

This conference on the theme “Chemistry: The Challenge of Change” will be held at Clemson University, South Carolina, USA. The conference is sponsored by the Division of Chemical Education of the American Chemical Society.

17-22 August, 1996
8th IOSTE Symposium

The 8th biennial IOSTE symposium will be held in Edmonton, Alberta, Canada.

For more information, contact:
Raja Panwar, Chairperson
Curriculum Standards Branch, Alberta Education
6th floor Devonian Building, East Tower
11160 Jasper Ave, Edmonton, Alberta, Canada T5K 0L2
Tel 1-403-427-2984; Fax 1-403-422-3745
e-mail RPanwar@edc.gov.ab.ca

21-27 August, 1996
GIREP-ICPE International Conference, in Ljubljana, Slovenia

Groupe International de Recherche sur l’Enseignement de la Physique (GIREP)-International Commission on Physics Education (ICPE) of IUPAP

For additional information contact:
Seta Oblak, Secretary of GIREP
Board of Education
Poljanska 28, 61 000
Ljubljana, Slovenia
Tel. 386 61 1333 266
Fax 386 61 310 267
e-mail: Seta.Oblak@guest.arnes.si

25-30 August, 1997
7th European Conference for Research on Learning and Instruction
Athens, Greece
Organised by the European Association for Research on Learning and Instruction (EARLI)
Contact Addresses:
Scientific Programme Secretariat:
Stella Vosniadou
Professor of Psychology
University of Athens
44 Ippokratous Street
106 80 Athens, Greece
Tel/ Fax.: 3640719
e-mail: svosniad@atlas.uoa.ariadne.t.gr

Conference Organising Bureau:
Eramus Horizon Ltd.
34 Vass. Georgiou B' Street
116 35 Athens, Greece
Tel.: 7257531, 7257693 5
Fax.: 7257532

27-30 December, 1996
NSTA International Convention
This convention, to be held in San Francisco, USA is intended to bring together scientists, school and college science educators and science education organisations worldwide.

For further information contact:
NSTA headquarters
1840 Wilson Boulevard
Arlington, VA 22201-3000, USA.

October 12-26, 1996
US/South Africa Joint Conference on Education
Johannesburg and Cape Town, South Africa

For additional information, please contact:
Kathryn Parker, Program Coordinator
Citizen Ambassador Program
Dwight D. Eisenhower Building
Spokane, Washington 99202
Phone: (509) 534-0430, ext. 466
Fax: (509) 534-5245
email: cap@amb-progs.com

6-9 January, 1997
International Conference on Science, Mathematics and Technology Education
Hanoi, Vietnam

Contact:
Thao Le
Faculty of Education
University of Tasmania
P.O. Box 1214
Launceston, Tasmania
Australia 7250
email: T.Le@educ.utas.edu.au

15-17 October, 1996
Technology Education for Development in South Africa

The conference will focus on solving problems facing educationalists who introduce technology education.

15-17 October, 1996
Technology Education for Development in South Africa

The conference will focus on solving problems facing educationalists who introduce technology education.

20-23 December, 1996
The Second Scientific Conference on The Future of Science and Mathematics Teaching and the Needs of Arab Society
University of Science, Technology and Medicine in Tunisia (Tunis 2)

Conference coordinator:
Mohamad Debs
Arab Development Institute
P.O. Box 14-5300, Beirut, Lebanon
Fax 01-212-4782932
e-mail cnrs10@calvacom.fr

3-10 April, 1997
10th ICASE Asian Symposium
This symposium will be held in Lahore, Pakistan with the theme “Empowering the teacher to promote scientific and technological literacy for all in the 21st century.”

For further details please contact:
Dr. Hafiz Muhammad. Iqbal
IER, University of the Punjab
New Campus, Lahore Post code 54590
Pakistan
5-11 April, 1997
10th ICASE Asian Symposium
This symposium will be held in Lahore, Pakistan on the theme “Empowering the teacher to promote scientific and technological literacy for all in the 21st century.”

For further details please contact:
Dr. Hafiz Muhammad Iqbal
IER, University of the Punjab
New Campus, Lahore, Post code 54590
Pakistan

22-26 April, 1997
Second ICASE Latin American symposium
(held at Mar del Plata, Argentina and hosted by Club de Ciencias Albert Einstein)

The Theme for the symposium is “To Improve Scientific and Technological Education for All: A Challenge for the Year 2000 and Beyond.”

For further information and to be put on the mailing list, contact:
SECRETARIAT:
Prof. Marta Moyano
Club de Ciencias “Albert Einstein”
Salta 2857 Planta Alta
(7600) Mar del Plata
Argentina
Tel/fax: 54 23 74 9556
email: leones@uni-mdp.edu.ar

Contact Addresses
Scientific Programme Secretariat:
Stella Vosniadou, Professor of Psychology
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106 80 Athens, Greece
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Cartoons as a Stimulus to Learning in Science

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We can be contacted at the following address:
Brenda Keogh and Stuart Naylor
30 Mill Hill Lane
Sandbach, Cheshire,
England CW11 4PN
Tel./Fax 01270 762340
ICPE Conference in Bangkok, Thailand
16-20 December 1996

Modern Science and Technology in School Physics Curricula for the 21st Century

Sub-theme for concurrent sessions:
—New Approaches in Physics Teaching
—Information Technology in Physics Education
—Computer and Multimedia in Physics
—New Technology and Equipment in Experiments
—Environmental Physics

OBJECTIVES:
The conference provides an opportunity for science educators, teachers from schools and universities, scientists to meet together in order to:

- share ideas and experiences in physics teaching
- interact with educators from different fields of interest in physics community
- provide awareness of environmental problems and issues through physics teaching

ORGANIZER:
The Institute for the Promotion of Teaching Science and Technology (IPST)

Supported by:
—Ministry of Education of Thailand
—ICPE at IUPAP
—UNESCO (Principal Regional Office for Asia and the Pacific)

CALL FOR PAPERS:
Contributed papers highlighting news and recent development in the areas covered by the conference are invited.

The closing date for receipts of titles and abstract (not exceeding one A4-page) is August 31, 1996. The abstracts should be camera-ready on A4-size (297mm x 210mm) the text must be type within the frame of 220mm x 150mm. The name of the author is to be underlined. Instructions for typing camera-ready manuscripts may be request from the secretary of the organizing committee. Abstracts and full paper text can also be in the form of 3.5" or 5.25" diskette (for IBM-PC) or email. Full paper must be submitted by October 15, 1996.

On request, the secretariat of the conference will send a personal invitation for participation in the conference. It should be understood that such an invitation is only meant to help participants raise travel funds or obtain visas, and is not a commitment on part of organizer to provide any financial support.

PROGRAMMES:
There will be keynote, plenary lectures, paper presentations, workshops, poster displays and exhibits. Details of the conference will be available in the second announcement.

VENUE:
The conference will take place at The Institute for the Promotion of Teaching Science and Technology (IPST), center of Bangkok

LANGUAGE:
The conference will be conducted in English. The national language is Thai. English is widely spoken in tourist centers and hotels.

VISA:
Those visitors who require a visa to enter Thailand should consult the Royal Thai Embassy or Consular Office for Visa information.

ACCOMMODATION:
Accommodation will be reserved upon request. Special room rates will be arranged at the venue of the conference and in nearby hotels, details of which are available from the secretariat.

REGISTRATION FEES:
Active Participants—U.S. $100
Accompanying person—U.S. $80

ALL PAYMENTS MUST BE IN BANKER’S ORDER OR BANK DRAFT

CONTACT:
Dr. Janchai YINGPRAYOON
Promotion of Teaching Science and Technology
924 Sukhumvit Road
Ekamai, Bangkok 10110
THAILAND
Tel: (+66-2)-3923772
Fax: (+66-2)-3810750
email: physics_ipst@mozart.inet.co.th OR yjanchai@mozart.inet.co.th
THE CEFIC SCIENCE EDUCATION AWARD

The European Chemical Industry believes that its future prosperity rests on the quality of the science education of Europe’s people. A thorough understanding of the fundamental principles of science and an appreciation of the impact of technology on our lives, and on the nature of the society in which we live, is already essential for survival in the modern world. European society cannot “opt out” but must equip itself to survive and prosper.

It is in this spirit that CEFIC has created its annual award for “Excellence in Science Education.” This award helps to:

- promote excellence in the teaching of science
- recognise the importance of teachers as major opinion-formers and show our desire for partnership with them
- build on the natural curiosity of young people about science
- show the industry’s willingness to be involved as a player equal to others in the community
- demonstrate our support for science and scientists.

The award

The award recognises excellence in science education, achieved by a teacher and a group of students. It is made on the basis of a project dossier created by the teacher and the pupils, which demonstrates both effectiveness in teaching and effective learning by the students.

Ann Burke from the winning school (Ireland) receiving the award from the president of CEFIC (Amsterdam 14 June 1996)
Extending and Improving Education in Science
for All Children and Youth by Assisting
Member Association Throughout the World

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Science Education International is the Quarterly Journal of the International Council of Associations for Science Education. ICASE was established in 1973 to extend and improve education in science for all children and youth by assisting member associations throughout the world.

This journal provides a means for associations, institutions, centres, foundations, companies and individuals concerned with science education, to share perspectives, concerns, ideas, and information which will foster cooperative efforts to improve science education, and which will serve as a chronicle of the advancement of science education throughout the world.

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Dates for Receipt of Contributions
Issue: Closing Date:
March 1 February
June 1 May
September 1 August
December 1 November

ICASE News ........................................... 2
Feature Article ...................................... 3
Science Education Around the World ............ 9
Research on Curriculum, Teaching & Learning ........................................... 15
Teaching Materials & Strategies .................. 21
Science Teacher Education & Leadership ........ 24
Non-formal and Informal Education .......... 30
Book Announcement ................................ 35
Book Review ........................................ 37
Calendar ............................................. 39

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ICASE GENERAL ASSEMBLY
Prepared by Jack Holbrook, ICASE Secretariat

According to the ICASE constitution, a General Assembly is held every four years. The last was held in Paris in 1993. It is very important for ICASE that member associations are strongly represented at the General Assembly as they are the Governing Body. Furthermore, the election of new officials is only possible if the General Assembly is constitutionally convened.

ICASE is making plans to hold the next General Assembly at the end of December 1997 in the UK (immediately prior to the ASE annual meeting). Earlier plans to hold the General Assembly in South Africa in July 1997 have collapsed. I will be able to give further details later in the year. I welcome queries and comments from any member organisation concerning the General Assembly, the manner in which new officials are nominated by member organisations and the procedure by which they are elected.

ICASE Homepage
ICASE now has a worldwide web site on the internet. The address is: http://sunsite.anu.edu.au/icase.

ICASE encourages all its member organisations to find ways to connect to the “web” and to establish email facilities. Email is easing worldwide communication and the “web” is certainly facilitating the dissemination of information. If you can be contacted by email, please tell me. My email address is: icase@zenon.logos.cy.net.

In the future, I would like to communicate by this means.

UNESCO Links
The ICASE worldwide web homepage is linked to the UNESCO homepage via information on Project 2000+ (the joint mobilizing project of ICASE and UNESCO). This link will be extended as ICASE and UNESCO work together to develop STL (scientific and technological literacy) teaching materials and other ideas useful to teachers.

Every member organisation should be receiving UNESCO’s INISTE/Project 2000+ bulletin. This is a biannual production, written for UNESCO by ICASE. (If you are not receiving a copy please contact me, or even better write to UNESCO directly: Chief STE, UNESCO, 7 place de Fontenoy, 75352 Paris, France. In your letter mention you are an ICASE member organisation.) I would welcome information about your activities to include in the bulletin. Please send also any feedback you may like to provide on the usefulness of the bulletin.

STL Teaching Materials
ICASE is encouraging the production and collection of teaching materials (individual lessons, courses, etc.) that are related to STL. To this end writing workshops have been held in Vanuatu (1995) and Estonia (1996) and further workshops are planned for 1997. ICASE will be publishing these STL teaching materials on the ICASE web site.

1999—The Year of International Links in Science Education

The ASE (UK) and ICASE are currently developing plans for schools to link across countries on a common project and for the outcomes to be available in 1999. ICASE hopes that its member organisations will be interested in promoting this scheme and help ICASE draw up a register of interested schools. A brochure will be made available shortly to explain the scheme in more detail, but the link is designed for students at any age level, studying any topic with the project proceeding for any length of time. The link may be between two schools in two different countries or could involve many schools in a multitude of countries working on the same project. ICASE would welcome expressions of interest in these ideas.

Membership Grows
Your organisation may be interested to know that the ICASE family continues to grow and currently there are 132 member organisations. This is double the 65 members in 1986.
SCIENCE TEACHER DEVELOPMENT IN DEVELOPING COUNTRIES

Ed van den Berg
Science and Mathematics Education Institute
University of San Carlos
Talamban Campus
Cebu City, Philippines
e-mail: edberg@durian.usc.edu.ph

Let me take you across the globe to a tropical island to a school in a small town on the other side of the mountains. One of my former students is teaching there. School facilities are reasonable, among the best of the island but all is relative. Only about 7 out of 45 students have a textbook, a rather common problem in many countries. When I attended one of the lessons my former student spent half the lesson dictating. We had trained her to use more creative methods, but what could she have done without books and with lots of exam pressure?

We board a flight to another country, where science is often taught by teachers trained in other subjects. Less than 10% of the teachers currently teaching physics are certified and in Chemistry only 20% are certified. At one in-service center I met about 60 teachers who now have their normal teaching load compressed into 4 days and spend every Friday and Saturday in certification courses. These teachers face classrooms with 50-70 students and most have extensive family duties as well (90% are women).

In yet another country, national plans require student laboratory equipment for several thousand schools. The investment will be 20-40 million dollars. But many teachers have had no pre-service teacher education and just a little in-service. In many countries expensive equipment projects have only had very limited results: science teachers long for equipment but do not use it due to a variety of factors including lack of familiarity, lack of teacher time (side jobs), lack of curriculum time and perceived irrelevance of lab activities for national or district examinations. Indeed, for teaching content, student laboratory may not be any better than demonstrations which require less equipment (Bates, 1978; Hofstein & Lunetta, 1982; Garrett & Roberts, 1982; Hodson, 1993).

Many developing countries are understandably in a great hurry to catch up and leaptfrog into the industrial era. Science education receives a high priority as science and technology are considered keys to industrial development. Many countries have carried out or are in the process of executing large, expensive, nation-wide teacher education projects in science. This paper will present some conclusions and suggestions with regard to teacher development based on common sense, research, and experience. The suggestions are presented as general, but may need some reinterpretation in each country and context.

Ausubel (1968) said: Determine where the student is (conceptually) and teach him/her accordingly. When thinking about teacher professional development, one should also ask the question: where are the teachers? And, where are their principals, where are their schools and educational systems in terms of management, facilities, vision, and resources?

Where Are Teachers, Principals, and Schools?

Teacher and school conditions can be categorized according to table 1. The table is a modified version of the one which originated in Beeby (1966), and was developed further by Verspoor (in Farrell & Heynemann, 1989, p. 54) and again by Feiter et al. (1994). In the table teachers are spread across a continuum which ranges from poorly trained teachers who do not sufficiently master the subject matter in the school curriculum, to professional teachers with good mastery of subject matter as well mastery of pedagogy and methods of teaching and learning science. Beeby (1966) conceptualized educational development as a four-stage growth process, moving from unskilled, to mechanical, routine, and professional phases. Unskilled teachers are those who do not sufficiently master the school subject matter they teach. They may be teachers from other subjects who are forced to teach science or they may be people who entered the system at times of great shortages of science teachers. Mechanical teachers
may master the school subject matter, but may use just
one dominant teaching method which is used
mechanically. The routine teacher does have proper
subject matter mastery, also beyond the school
curriculum, and mastery of a repertoire of teaching
methods. However, the routine teacher is not yet or not
anymore involved in professional development in which
teachers continuously develop their repertoire of
teaching methods, examples, and background
knowledge, or has regressed to use only a narrow band
of teaching methods.

In many (but not all) low-income or developing
countries unskilled teachers are still quite common.
However, also in high income countries one finds many
teachers who are not certified (and perhaps not able) to
teach subjects like physics. Also in high income
countries most teachers are functioning at the
mechanical or routine levels rather than the professional
level. The main difference between low income and
high income countries may be in the proportion of
teachers at the unskilled and mechanical levels (higher
in low income countries) and the routine (higher in high
income countries) level.

School conditions can be similarly categorized
(Berg et al. 1995), but do not necessarily exactly parallel
the teacher column. In most countries a thin upper layer
of top schools is well organized and disciplined with a
professional teachers corps. Below that there is a broad
layer of “average” schools which experience the typical
problems of developing countries: low budgets,
teaching staffs with limited motivation and outside jobs
to supplement their low incomes, and management of
varying quality. Below the middle layer of “average”
schools is another big layer of poor quality schools with
high percentages of deprived students. These schools
are inadequately financed with under-qualified staff,
poor management, and poor discipline (frequent absence
of teachers, poor grading practices, etc.). On average
poorly managed schools have more unskilled teachers
than well managed schools. However, a well trained
teacher may be stuck in a poorly managed school and the
other way around, especially in countries where
teachers are hired and placed by Departments of
Education rather than by schools.

Beeby’s model can be linked conveniently with
implementation of new curricula and teaching methods
in which there might be a progression from non-use (of
new methods/materials), mechanical use, and routine
use to refinement and integration of new instructional
materials (for example: a new curriculum) and teaching
methods (Joyce & Showers, 1988). Both the
characteristics of the teachers and the characteristics
of the schools put serious limits on what is possible
in educational improvement or reform. Frequently
the different categories of schools and teachers are not
recognized and countries design uniform programs for
all schools and all teachers.

Table 1: Classification of teacher and school
conditions (modified from Feiter et al., 1995)
(see page 8)

Teaching Methods

Many countries and “expert” consultants like to
promote the most “modern” teaching methods in their
projects such as constructivist teaching, inquiry, pupil-
centered, etc. The problem is that most methods under
these broad and fashionable categories require high
sophistication from the teacher and rather favorable
boundary conditions in the school. Furthermore, the
superiority of such methods for many educational goals
(especially those tested by the traditional exams of many
countries) has not been proven on national scales,
although success may have been demonstrated in special
settings (Walberg, 1991). Sophisticated methods can
only realistically be promoted for teachers and schools
from the “professional categories” and even then the
methods will have to be adapted to use with large classes
(40 students per class or more in most developing
countries).

To determine what can be done in the lower
category schools with lower category teachers we might
want to look at the literature about effective teaching.
Joyce and Showers (1988, p. 55) state that the more
effective teachers:
• teach the classroom as a whole;
• present information or skills clearly and
   animatedly;
• keep the teaching sessions task-oriented;
• are non-evaluative and keep instruction relaxed;
• have high expectations for achievement (give more
   homework, pace lessons faster, create alertness);
• relate comfortably to the students, with the
   consequence that they have fewer behavior
   problems.

Based on a review of many studies, including
studies in developing countries, Walberg (1991, p. 44)
comes to a very similar list. Successful teachers practice
the following steps:
• daily review, homework check, and, if necessary,
  reteaching;
• rapid presentation of new content and skills in
  small steps;
• guided student practice with close teacher
  monitoring;
• corrective feedback and instructional
  reinforcement;
• independent practice in seatwork and homework;
• weekly and monthly review.
Fuller and Clarke (1994) in their synthesis of studies from developing countries found support for some of these practices as well. For example, frequency of homework was a significant factor in 80% of the studies which included homework as a factor.

What Can be Done at the Different Levels of Table 1?

Unskilled teacher, poor school: To turn an unskilled teacher into a skilled one who masters the subject and its pedagogy takes years (the years of pre-service!) and there is no guarantee that the unskilled teacher can succeed. Changing school management from poor to good may require replacement of principals, vice-principals and even school boards (private schools), which is difficult in any culture. Making sure that kids and teachers are in their classrooms when they have to be, would already be an improvement in many cases. What could be done is to provide textbooks and teach teachers how to use them (without special training, many teachers continue to dictate). If more funding is available, one could think of certification courses for unskilled teachers who have sufficient potential. Such courses should apply a well defined minimum level for graduation (e.g. mastery of school science at the level of final exams for secondary schools in that country). Furthermore, one could promote those effective teaching practices which do not require much skill such as giving and monitoring homework (random but regular checks to limit teacher work), use of tests which are relatively easy to mark taking into account the subject matter mastery and time of the teacher. In-service could focus on simple homework assignments and how to monitor and correct them and the same for tests. However, one should be aware that poor school conditions might interfere with any in-service efforts.

Routine or mechanical teacher, average developing country school conditions: Here one could try to improve conventional teaching by adding variation, and improving mastery of school science (McDermott, 1990). By necessity one would have to concentrate on changes which require little teacher preparation time and are correlated with performance on the typical exams of the country concerned. One should concentrate more on fine tuning and extending (Joyce & Showers, 1980) existing teacher repertoire than adding completely new methods which require in-class coaching. Table 2 summarizes suggestions. A beautiful resource for demonstrations with simple equipment and spectacular results is the book Invitations to Science Inquiry by Liem (1987). The book is popular in the USA as well as developing countries. We used it very much in pre-service as well as in-service activities in Indonesia and the Philippines. Secondary school students respond very positively to variation, demonstrations, and whole class discussion. The demonstrations require good classroom control, but disorder is less of a problem in most developing countries compared to industrial countries.

Obviously one should try to get the mechanical teacher to cross over to the professional category by trying to involve them in school-based development and in professional organizations.

Table 2: Improving Conventional Teaching

- Mastery of school science with emphasis on conceptual aspects and examples and applications in the student's environment;
- Increasing classroom interaction through questioning;
- Training in interactive demonstrations with universally available equipment;
- Training in the use of Predict-Observe-Explain demonstrations;
- Making concepts more "visible" through use of common objects as teaching aids;
- Linking science with the local environment and technology;
- Teaching systematically through use of objectives and a logical sequence;
- Frequent home work and monitoring of student work and achievement;
- Attention for individual students;
- Attention for student conceptions;
- Attention and regular feedback for student assignments;

Professional teachers and schools: One could promote sophisticated teaching methods here as teachers have the ability and are willing to spend the time to implement them. However, teacher educators should focus on teaching methods which are realistic in large classes as even top schools enroll over 40 students per class and sometimes over 60. Furthermore, one would have to keep in mind the nature of the matriculation and university entrance exams students are preparing for. The teaching cannot be too individualized. Predict-Observe-Explain demonstrations (White & Gunstone, 1992), concept maps, use of analogies, (open-ended) problem solving and other "minds-on" teaching methods could be promoted. Use of the laboratory is possible and recommendable if one is mindful of the many pitfalls of laboratory teaching (Hodson, 1993). It should be realized that sophisticated teaching methods need labor intensive and expensive in class coaching for teachers to overcome the typical implementation dip (Joyce & Showers, 1980, 1988). Such expert coaching.
is often difficult to provide in both developing and industrial countries. On the other hand, many professional schools in developing countries have great opportunities with eager and smart students and dedicated teachers. In such cases one should set ambitious targets for educational development.

Laboratory Equipment
Considering the many studies raising question marks regarding the use of the laboratory (Hofstein & Lunetta, 1982; Garrett & Roberts, 1982; Hodson, 1993) one should be very cautious in recommending large scale equipment projects, especially as many such projects in developing countries have failed and equipment remains under used. Student laboratories may only be meaningful for teachers and schools who/which are at the mechanical or professional level. Other schools and teachers should at least have simple demonstration equipment. When selecting equipment, one might want to go for demonstration only if the purpose of the experiment is mainly to illustrate concepts and theory and reserve the multiple set-ups for experiment where the focus is either on exercising manipulative and measurement skills or on training investigation (inquiry) skills.

Conclusions
Teacher development projects in developing (and industrial!!) countries should not provide universal recipes for all schools and all teachers, but should choose different approaches depending on teacher and school backgrounds. In certain situations simple actions (homework) can have large effects while expensive actions (provision of laboratory equipment) may or may not have effects. Promoting improvements of conventional teaching (table 2) may have more effect in “average situations” than promoting the “top ten” modern teaching methods from the haute couture of science education.

Notes
With developing or low income countries I mean low and moderate income countries located mainly in Asia, Africa, Latin America, the former Soviet Union, and the Pacific. No narrow and linear conception of “development” is implied.

The author worked in Africa with UNESCO, taught for ten years in a science and mathematics teacher education program in Indonesia, worked for five years in teacher education in the Netherlands, and is currently stationed at the Science and Mathematics Education Institute of the University of San Carlos in the Philippines in an inter-university cooperation project with the Free University of Amsterdam.

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<table>
<thead>
<tr>
<th>Teachers</th>
<th>Textbooks/ Facilities</th>
<th>Teaching Methods</th>
<th>Schools</th>
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<tbody>
<tr>
<td><strong>Unskilled</strong></td>
<td>Frequently only one or a few textbooks per class of 40+ students, absence of other instructional materials, or not used.</td>
<td>Emphasis on rote learning. Students copy from blackboard or dictation; no monitoring of individual students.</td>
<td>Continuous financial problems, focus on survival. Poor management, sometimes corruption with money and exams.</td>
</tr>
<tr>
<td><strong>Mechanical</strong></td>
<td>About 20% of the students may have science textbooks. Almost no other instructional materials. Some science equipment available but often not used.</td>
<td>Rote learning, slavish adherence to curriculum, short term activities and objectives, rigid application of one teaching method. Dictation not uncommon.</td>
<td>Management limited to administrative control and compliance (or not) with regulations. Little attention of leadership for what happens behind classroom doors.</td>
</tr>
<tr>
<td><strong>Routine</strong></td>
<td>20-100% of the students may have textbooks. Limited sets of science equipment available but under used. Other support materials (books, etc.) present.</td>
<td>Memorization still, but increasing attempts to introduce &quot;learning by doing&quot;, medium term planning using textbooks and materials in a more goal-oriented way, limited variation, attention for individual students.</td>
<td>School is run in a routine way without a development plan. There is some attention for school development through occasional in-service and some spending on instructional materials.</td>
</tr>
<tr>
<td><strong>Professional</strong></td>
<td>All students have textbooks, alternative textbooks available, well-stocked school library, variety of instructional materials. Complete laboratory.</td>
<td>Self-generated habits of learning; ability to generate new ideas; longer-term instructional planning allows teacher to adapt use of materials and curriculum sequence to student needs; individualized or multi-group instruction.</td>
<td>Competent management and school discipline, there is a school development program with a realistic budget, ample attention to pedagogic support, sometimes support services (media, technical) available.</td>
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*Subject matter mastery in this paper means mastery of the science in the school curriculum (not mastery of college level science).
DIFFICULTIES OF SCIENCE INSTRUCTION IN THE KINGDOM OF LESOTHO

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A Historical Perspective

During the colonial period, the missionaries controlled the education system in the kingdom of Lesotho and laid down the foundation of modern education. However, they did not integrate the system with the indigenous approach that reflected the local culture and had prevailed in the country for centuries (Moletsane, 1982). Consequently, the lives and aspirations of the local people are poorly represented in the modern system of education in the country.

During the colonial period a strong infrastructure for modern education was built, especially at the secondary level, but science education did not have a significant place in the curriculum. Today this missionary based educational system has little value for a society in need of science and technology training. After independence the government took over control of the education system and emphasized science education for national development. Since then the government has been trying to improve its science education programmes at all levels.

In spite of all efforts, it seems the situation has not been improving much. The nation is yet to meet its manpower requirement in the areas of science and technology. Over the years students' performance in science at various levels have been declining instead of improving (Talukdar, 1989). However, the nation is desperate to improve its education, particularly science education. A land locked country like Lesotho with almost no significant natural resources cannot afford to ignore the role of science and technology in its economy.

Develop its educational programmes. Many donor agencies came forward to help the country. American peace corps, German development workers, and Nigerian volunteers are very active in Lesotho and have been trying to improve science education programmes as quickly as possible. Similarly, the Dutch government, the European community, and the British council have also been contributing generously in many ways.

The department of science education at the National University of Lesotho prepares science teachers for secondary schools in the country. In the department, the Free University of Amsterdam and the European community have been supporting science and mathematics teachers' training programmes through the Centre for Inservice Education of Mathematics and Science Teachers (CIEMST). The centre has been in existence for more than a decade now. During this period it has been very active in supporting the inservice as well as the preservice science and mathematics teachers' training programmes. The centre staff regularly visit schools, liaise with the ministry of education officials and other interested parties with the goal of improving science education. The German development services provide development workers to support many activities of the centre.

The centre is now planning to extend its activities to non-science teachers. To accomplish this the CIEMST is attempting to become an independent entity in the National University of Lesotho within the faculty of education. The proposal is awaiting approval at the time of publication.

Partners in Development

Like many developing countries, after independence the kingdom of Lesotho was faced with economic problems as well as a dirth of expertise to
Science in Education

Primary Level

The duration of primary education in Lesotho is seven years. There is no minimum of maximum age limit specified for entry into the school system. Presently there are more than 1200 primary schools employing about 6000 teachers. About 7/8ths of the nation's student population are at the primary level. A small fraction of primary level students proceed to the secondary schools. It seems primary education is the terminal schooling for most of the people in Lesotho. At the end of this level, pupils write Primary School Leaving Examinations (PSLE), conducted by a local examining body.

Science is a compulsory subject at the primary level and about 15 to 20 percent of the teaching time is given to it. However, there is no separate teacher for teaching science. The primary level teachers studied very little science in their training programme. That knowledge is not adequate for teaching science. Often nontrained teachers are asked to teach the science.

Secondary Level

The secondary education is of five years duration consisting of three years junior secondary and two years senior level. Presently there are about 200 secondary level schools in Lesotho. At the end of the junior level, a junior certificate examination is administered. After two years of senior secondary education, the Cambridge Overseas School Certificate (COSC) examination is taken.

Only about 1/8th of the nation's student population study at the secondary level. A very small portion of those have the opportunity for higher education.

Science is compulsory for all during the first three years of secondary education. At the senior level, science subjects are optional and follow the COSC syllabuses. Combined science is the most popular senior option in Lesotho. Very few schools in the country are in a position to offer separate science subjects because of lack of qualified teachers and facilities.

Tertiary Level

The condition of higher education is also not very encouraging. Less than 1/2 of 1 percent of the entire student population in the country have an opportunity for tertiary education. Among them only 10 percent opt for science or science based disciplines (World Education Report, 1991). The main higher educational institution in the country is the National University of Lesotho. The National Teachers Training College, Lesotho Agricultural college and few other technical schools provide post secondary education but not at the degree levels. The opportunities for tertiary education are very limited.

The National University of Lesotho has well developed faculties for science and agriculture which aim at preparing highly qualified manpower for the nation. The university basically offers four-year programmes leading to first degrees. The diploma programmes are of three-year duration whereas some one year certificate programmes are also available. The honours, masters and Ph.D. degrees are offered in some departments. The statistics for the last 15 years suggests that the university has not been expanding in terms of number of intakes or facilities (Talukdar, 1989). Presently, about 20 percent of 1800 students of the university are in the areas of science.

Problems of Science Education

Lack of Qualified Teachers

Perhaps the teachers' role in classroom instructions is by far the most important component to our national science educational goals. It is the teacher who implements a curriculum or programme of study by teaching courses, organizing teaching learning activities, and using other available resources for instructions. Without the support of an efficient teaching force, no programme of study can be effective. Even a lavish budget is sure to fail to produce a positive result without a strong, professional and dedicated teacher community.

It is not surprising to see that many nonscience teachers teach science in Lesotho school system. The supply of science teachers is far below the demand. The countries 200 secondary and high schools need at least 1000 teachers to teach science adequately. Most of the schools are under staffed in all subjects, especially science. Nongraduate science teachers constitute the main body of science teaching staff.

The only university in the country produces about 20 to 30 science teachers annually. This does not include another 25 agriculture teachers who also teach science, mainly at the junior level, or the National Teachers' Training College who prepare a small number of teachers with science background annually. To add to the problem, a significant proportion of these science teachers find employment across the border, join other sectors of the economy or travel abroad for further studies.

Teachers in Lesotho have been complaining about their low wages compared with their counterparts across the borders. Many good teachers, local or expatriate, are migrating to neighboring countries.
Shortage of Resources

The success of teaching and learning science depends, to a large extent, on the proper use of resources. For science teaching especially the way the curriculum is designed, a laboratory is essential. In Lesotho schools, the laboratory facilities are seriously lacking and some schools teach science without a laboratory. In addition the condition of school laboratories is very poor. Many schools which have laboratories, have no water, no electricity, and no equipment for teaching science. Some of these laboratories are used as normal classrooms or staff rooms (Chisman, 1985). Schools have simply not developed a system of maintaining laboratory facilities at a reasonable level. The funds available for the laboratories are very limited and often insufficient. Even when funds are made available, schools fail to utilize the fund meaningfully and economically. Poor management and lack of adequate funding are two prominent reasons why the schools in Lesotho are short of resources for teaching science effectively.

Nonchalant Attitude of Teachers and Pupils

It is not only the subject knowledge of teachers but also the right type of attitude toward work which is essential for successful teaching. Even when their content knowledge and pedagogical skills are satisfactory, the nonchalant attitude of many teachers toward their work and science contribute to the poor student performance. A significant number of teachers do not show any interest or enthusiasm for their profession. For example, they are late to class, do not mark the continuous assessment properly, lessons are poorly organized, and at the time of examination teachers overload pupils with assignments and other work.

This nonchalant attitude is not a problem of science teachers alone. Other teachers as well as pupils also behave in this manner. Pupils are not serious in their studies and home assignments are not done regularly. Pupils' main purpose of study is to pass the examination, hence they study only on the eve of examinations.

Of course pupils' attitude is greatly influenced by the teachers' attitude. When pupils see that their teacher is not coming to class on time, gradually they also learn to come late. When the pupils notice that the teacher does not mark their assignments on time, they tend not to complete their assignments in time. If a teacher is considered to be the model, definitely the model described above cannot be acceptable for shaping the behaviour of our children. It seems nobody gives any attention to this aspect of teachers' and pupils' behaviours.

The Problem of Books

The lack of locally produced textbooks and other related literatures is a serious problem in the country. Some textbooks for primary and junior secondary levels are locally produced. The textbooks for upper levels are all imported and hence do not reflect the local conditions. Students do not see the reflection of their local environment in these books which reduces their interest in reading them.

The other problem is the high cost of books. The books are too costly compared with the income of many parents. For example, one volume of junior science textbook which is produced locally, costs in the range of R30-R40 in the market. An imported book of that type will cost even more, something around R100. A parent who finds it extremely difficult to pay the school fee of about R200 per year for a child, can definitely not afford to buy a couple of such books. It is not just one book a parent has to buy. This is truly an obstacle against acquiring and using science books. It is vital that something be done about this.

Weakness in English and Mathematics

A strong background in English and mathematics is essential for success in science. In Lesotho the weakness of pupils in English and mathematics is a great obstacle for teaching and learning science (Talukdar, 1995a).

One of the unfortunate things for the children of Lesotho is that they must study at schools in a foreign language and not their mother tongue. Many times children have to give more effort to learning the language than understanding of the subject. In Lesotho, English is the medium of instruction for the primary level. But the English language ability of pupils is extremely poor. The COSC results from 1979 to 1988 show a steady decline of student's English performance (Department of Science Education, 1991). The trend continues today.

There are numerous scientific concepts in English which do not have equivalences in local language. It is difficult for science teachers to teach such concepts. It is also well documented that the properties of concepts must be experienced by the learners before they can grasp their meanings correctly. Many teachers are not even aware of this problem or its solution.

Communication in the class becomes even more difficult when different teachers speak English in different accents. The children find it difficult to switch from one accent to another. Add these problems to the fact that teachers frequently move thus forcing children to adjust to yet another accent or style of language.

A strong background in mathematics is another prerequisite for success in science. In fact, mathematics
is the language of science. Mathematical arguments, logic, and symbolism are used to communicate the ideas in science. In Lesotho, pupils are very poor in mathematics. The results in this subject are so poor that many fail to fulfill the admission requirement for higher education.

Inefficient Management and Administration

The management and administration of educational institutions is another critical factor which affects the performance of pupils in their academic achievements. The ineffective management and poor administration of educational institutions in Lesotho have contributed greatly to the poor standard of education.

Schools, for the most part, fail to monitor the activities of individual teachers, manage laboratory funds, or recognize the special need and status of science instruction. Even if some donation of equipment or materials goes to a school, they are not properly maintained or stored. It is a problem of gross inefficiency. At times, it seems that no one is accountable to anyone for his or her activities. The lack of proper accountability is a serious problem of management and administration.

What Should Be Done?

Many teachers and other interested parties genuinely believe that the issues discussed above should be taken seriously. Just talking, discussing and lamenting will not help. Something concrete has to be done. Otherwise the situation will not improve. At this juncture, the country needs dedicated researchers and sincere workers to address these issues.

Debate and Research

The university and the ministry of education should initiate research and debate in the society aimed at understanding clearly the real problems of science education. Such research and debate could yield reliable information about the status of science education in the country and lead to dependable solutions. The research is costly and time consuming; whereas, the debate is quick, less expensive and does not involve specific technical expertise. The debate has the advantages and disadvantages of taking into consideration the political views of the people.

Nurturing Right Attitudes and Behaviours

Teacher education institutions such as the National University of Lesotho and National Teachers Training College should accommodate the question of teachers' attitude and behaviour in their programmes of teacher training. Workshops, seminars, and debates should be organized regularly on these matters. One cannot change the attitude of people overnight by mere advice. Long term education is needed. Such education will give the teacher an opportunity to analyze the matter and understand the pros and cons of it. The ministry of education should also take definite steps to address the issue. The CIEMST at the National University of Lesotho may be in a better position to launch various short-term programmes about the values and attitudes of teachers. Regular visits to schools by dedicated inspectors and their advice to teachers may also provide positive results.

The possibility of imposing punitive measures such as temporary suspension from work, withholding increment in salary, or transferring a teacher for wrongdoing should be implemented.

Supply of Textbooks

The government should formulate a policy of publishing and supplying educational books at a reasonable price. Many Third World countries are doing so. The government of Lesotho should try to encourage local writers to write books, set up printing and publishing techniques, and develop structures for marketing educational books cheaply, and to sign agreements with foreign publishers to publish books locally. A good network of public and school libraries must be set up and maintained as well by establishing a provision for such expenditures in the yearly national budget of the country.

Supply of Qualified Teachers

Special arrangements or provisions should be made for ensuring the adequate supply of qualified and dedicated science teachers in the school. Careful consideration should be given in recruiting science and mathematics teachers so the poorly qualified cannot enter the system. A poor teacher will produce low achieving graduates who, in turn, affect the national economy as well as the future teaching force. This vicious circle will continue without higher standards being implemented.

The government should devise some mechanism to give additional incentives to science teachers, perhaps by giving them additional allowances or other benefits. Presently, a science graduate can get more salary and benefits in other sectors of the national economy. There is a tendency to move from teaching to nonteaching jobs. An adequate incentive is needed to reverse the movement so that the schools can attract better people into teaching.

Improving English and Mathematics

Urgent attention is to be given to the English language acquisition at all levels of Lesotho education. The teaching of English language must be emphasized
at the primary level where the foundation of language is developed. Without the mastery of language, the study of science will continue to be hampered.

School must have enough English teachers for small group instruction appropriate for learning a foreign language. Moreover teachers should be trained with appropriate methodology suitable for local school situations.

Similarly, the problem of mathematics should be dealt with right from the beginning (i.e., at the primary level). A strong background in mathematics at the primary level must be established.

The CIEMST within its scope could do a lot about these training concerns. It can design a variety of in-service activities with a view to improve the situation. In addition the preservice teacher trainers of English language at NUL and NTTC could advise CIEMST and together draw a joint plan of action. The same applies to the problem of mathematics.

The Question of Research

The government of the kingdom of Lesotho, like many other developing countries, cannot afford to supply sufficient equipment and materials to a ever increasing number of schools and other educational institutions. This is a problem for all Third World countries, and it will remain for many years to come.

For teaching science, especially at the lower levels, many locally available materials must be used. Too many teachers have developed an attitude that fancy and sophisticated equipment and materials are the only resources for teaching science. They hardly see things in their environment which can be used for teaching science almost without any cost. The government should take the initiative to train teachers in using such materials for teaching science. This is the only way to solve the problems of equipment in our school system.

Conclusion

The geographic and the present economic conditions of Lesotho require that human resources be developed to the fullest. They have to be educated in science and technology to be competitive in the job market. The country must expand its industrial base for creating jobs and goods which require the application of science and technology. Only then can Lesotho move toward it's full potential.

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NATIONAL SCIENCE EDUCATION STANDARDS: GUIDELINES, NOT CURRICULUM

Gerry M. Madrazo & Gretchen Van Vliet

The United States National Research Council released the National Science Education Standards in December after a year-long process of public review and comment. The goal the NRC hopes to achieve is to give all students regardless of gender, race, motivation, or physical or learning disabilities the “opportunity to attain a higher level of scientific literacy than they do currently.”

With funding from the Department of Education, the National Science Foundation, NASA, and the National Institutes of Health, the NRC sought input from educators, school administrators, school board members, parents, business leaders, curriculum developers, publishers, scientists and engineers, and public officials. The result is a 262-page document that offers standards for science content; science teaching; professional development for teachers; assessment of teachers, students and programs; science education programs; and entire school education systems.

While the Standards are voluntary, the NRC emphasizes that the Standards do not suggest a science curriculum; rather, they offer guidelines and tactics for analyzing our progress toward a higher national standard of science education. The NRC recognizes that implementation of the Standards will be “costly, time-consuming and require major changes in much of the country’s science education.”

The underlying principles of the Standards are outlined as: 1) science is for all students; 2) school science reflects the intellectual and cultural traditions of contemporary science; 3) learning science is an active process; and 4) improving science is part of systemic education reform.

The largest section of the Standards document focuses on science content standards. These outline what students should know, understand, and be able to do at various grade levels. The eight categories identified are: unifying concepts and processes; science as inquiry; physical science; life science; earth and space science; science and technology; science in personal and social perspectives; and history and nature of science.

The content standards break down into what students should learn in grades K-4, 5-8, and 9-12. For example, in life science, the standards specify that students K-4 should know the characteristics of organisms; life cycles of organisms; and organisms and their environments. In grades 5-8, students are expected to learn the structure and function in living systems; reproduction and heredity; regulation and behavior; populations and ecosystems; and diversity and adaptation of organisms. For life science, students in grades 9-12 need to be taught about the cell; the molecular basis of heredity; biological evolution; the interdependence of organisms; matter, energy, and organization in living systems; and behavior of organisms.

The other standards outlined in the NRC document offer direction at all levels of the educational system. Science teaching standards include direction for planning a science program; guiding and facilitating learning; assessing learning and teaching; designing and managing the physical environment; building learning communities; and school planning. The standards for professional development identify it as a continuous, life-long process; is applicable to the teacher’s daily work; requires learning science content through inquiry; provides professional intellectual growth; and is not skill-based technical training.

The assessment standards focus on assessment with clearly-defined purposes; measuring student achievement and opportunity to learn; matching technical quality of data with consequences; avoiding bias; and making sound inferences. The program standards look at school and district opportunities for students to learn and teachers to teach. These consist of consistency within and across all grades K-12; effective curriculum; science coordinated with mathematics; quality resources including teachers, time and materials; equity and excellence; and schools as communities of learners.

Finally, the Standards document looks at system standards that provide criteria for judging the components of the science education system. These standards include a common vision and coordination across the system; continuity over time; a program supported with resources; equity; unanticipated effects; and individual responsibility.

To order a copy of the National Science Education Standards for $19.95 contact the national Academy Press at (202) 334-3313 or (800) 624-6242. An overview of the Standards is available on World Wide Web at http://www.nas.edu.

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A COMPARISON OF PRINCIPLES OF TECHNOLOGY AND TRADITIONAL PHYSICS

Steve Wignall

This article will take the Principles of Technology (PT) curriculum offered through the Center for Occupational Research and Development (CORD) and compare it with traditional physics classes offered in high schools across the United States. As a classroom teacher, my reasons for researching this topic are to discover the similarities that I believe exist between these two curriculums, and also to find some of the issues that have caused concerns in both programs. This will be accomplished by discussing the Principles of Technology in four parts. The first part will cover the reason for the conception of the course, the second part will discuss its development, third will be a discussion of advocates of PT, and fourth a Physics perspective of the course related to subject matter previously discussed on PT in the research.

Conception of Principles of Technology (PT)

The creation of PT began back in 1983 when the State Directors of Vocational Education began worrying about students, in their states, math and science abilities (Agency of Instructional Television (AIT), 1983). They were concerned that students did not possess the tools from the way the high school programs were being taught to enter into the work force at an acceptable level. Because of this they asked the Center of Occupational Research and Development (CORD), with the assistance of the Agency of Instructional Television, if they could recast the typical Physics class and make it more applicable for a vocational student going into the ever more technical work place of today. A statement by one of the developers, Leno Pedrotti (Barinaga, 1990), sums up the intent of the Principles of Technology project. He stated: “Our target was to bring more kids into physics, but not into the higher track. It’s physics for technology and technicians. We use the laws of physics to show how everyday industrial devices work.” With these goals in mind the project was then developed.

Development

When the development of PT is discussed the only way to look at this is from two viewpoints. The first is the historical perspective, and the second is the changes in the traditional school curriculums that had to occur for it to be implemented.

In order for the development of the PT curriculum to begin CORD and AIT had to first collect funding from Consortium schools in the amount of approximately two and a half million dollars to start the project (AIT, 1983). A consortium of thirty four state and Canadian provincial agencies bought into the original project. In the United States the monies that the states devoted to this project were through money that each had received through the Carl Perkins Vocational Educations Act. The Perkins money is still a big part of this program today. Examples of this include: funding and stipends for those training to teach PT, purchasing some of the equipment used in PT, and paying for substitutes and travel allowance to let teachers visit PT schools to expose them to this concept of instruction.

Instructional Design

The instructional design of this program was the hardest thing for the developers to attain. The original time line for this project called for implementation by September of 1986. This did not prove to be the case. Due to arguments in the Consortium meetings about Technology and Science, math skills, and having the equipment to do PT “In House,” the curriculum went through another revision from 1989 -1992 before it reached the final version used today. The developers listened to the states, schools, teachers, and students to get the best feedback from all.

The areas covered in the original project were separated into two years. Year 1 covered Modules 1-6 and Year 2 Modules 7 - 13. The modules would cover approximately 4 weeks of instruction each. The modules for year 1 were:
After field testing the original curriculum in 60 high schools around the country (Pedrotti, 1996) the only content changes made to the two year program, involved adding one more module and revising the order of units taught (Center for Occupational Research and Development [CORD, 1992]). The final units and their order are as follows:

1. Force 8. Momentum
2. Work 9. Waves and Vibrations
3. Rate 10. Energy Converters
4. Resistance 11. Transducers
5. Energy 12. Radiation
7. Force Transformers 14. Time Constraints

The first year of instruction is units 1-7, and year two is units 8-14.

Advocates of PT

To show the support that the Principles of Technology program is receiving throughout the country, I will review how the PT curriculum is viewed by businesses, and schools.

Businesses—Many, if not all, companies in the United States and the world are seeing the survival of their business resting in the hands of technology. If employees are not trained in the use, and understanding of these technologies then their work place must provide this education. This need has gotten many companies actively involved in the implementation of programs such as PT into schools. An example of this is The Boeing Company which met with Washington state education leaders to determine what help they might provide to ensure that schools were putting out more qualified graduates into the future work-force. The Washington state educators and The Boeing Company agreed that the company could assist in the following manner no matter what program graduates might eventually be employed in (Wang and Owens, 1995):

1. Using its influence as the state's major employer to convince education policy-makers at local levels of the benefits of applied academics courses.
2. Validating that new kinds of basic skills are needed in the workplace.
3. Providing seed money to local schools with applied academics programs to purchase equipment and materials and to reimburse expenses for teacher release time.
4. Providing opportunities for applied academics teachers to see their subject areas being used in state-of-the-art work settings.
5. Providing incentives and resources to encourage high school and community college faculty to link
their programs and to encourage community college faculty to change selected curricula to applied approaches.

Though not mentioned above, the programs that The Boeing Company primarily supported were PT and Applied Math (AM) as recipients of their help as shown in “The Boeing Company Applied Academics Project Evaluation: Year Four” (Wang and Owens, 1995).

Many schools in Washington state have eagerly accepted the PT programs and other applied classes into their curriculums, but what about other schools not as fortunate to receive help from outside to the extent of these schools, do they also accept PT as a course they are excited to receive?

**Schools**—Richard L. Goodworth a superintendent at Bonneville High School in Idaho gave this analogy of PT (Selland, 1986):

“We found it to be a highly academic, yet motivating, vocational course which can and does provide much needed skill training for students electing to participate. We are very pleased with the opportunity of working . . . in this most creative course.”

John Roper, a principal at North Shore Regional Vocational High School in Beverly, Massachusetts agrees that PT is an excellent vocational class, but goes one step further in his expectations of this course. He states (Roper, 1989):

“If we change the way physics is taught, we can communicate with those who learn in different styles. We should not drop the courses that are successful for some. Rather, we should add courses that might be successful for others. One such course is the *Principles of Technology* physics program.”

Before getting into the benefits seen by teachers who instruct PT, one question should first be raised. That question is “Who should teach *Principles of Technology*?” The original answer to this question was the vocational teacher at the school. But, according to CORD (1992) in the field testing, several types of teachers successfully taught PT:

1. Vocational electronics or electromechanics teachers (some drafting teachers with one or more courses in college physics).
2. Industrial arts teachers with one to three courses in college physics.
3. Physics teachers with some industrial or applications background and interest in *Principles of Technology* course format.
4. Teams of teachers with a physics teacher doing the classroom (frontal) teaching and math labs, and a vocational teacher doing the hands-on-labs. The team teaching approach has been found to be particularly successful where the two teachers sit in on each other’s class.

From the list above, it becomes apparent that in order for this curriculum to be successful the instructor needs to have at least some knowledge in physics, math, and some vocational experience (Moreira, 1994). As stated by an Introductory Information paper put out by CORD (1992),

“Teachers with more extensive physics background tended to be more successful in implementing *Principles of Technology*. Although most students demonstrated a learning gain, those students whose teachers had a more extensive physics background tended to have more pronounced learning gains.”

The information above gives a background of the type of teachers that tend to have favorable experiences with PT. This does not mean that teachers without some science background, or vocational experience cannot also be successful in this program. Through proper training in workshops offered for assistance in teaching PT, these teachers can also develop programs that are very beneficial, and satisfying.

The advantages of PT instruction in the material reviewed from a teacher’s standpoint really can best be categorized from the results gathered in a survey on “Schools Opinions on PT” by G. Gloeckner in 1990. In this survey Gloeckner reveals that:

- 71 percent of the students earned an “A” or “B” in their first semester PT class.
- 47 percent of the students who responded stated that they planned to enroll in a science course next year; 34 percent indicated that taking PT made them want to enroll in future science classes.
- 80 percent of the students who responded agreed that PT classroom demonstrations clarified mathematics and physics concepts for them.
- 67 percent of the students felt that PT instruction, as compared to other traditional science courses, better prepared them for a technical career.

The data collected in the survey not only looks favorable from the standpoint of the teacher, but more important, the students who are taking the PT class.

**Physics Perspective**

Traditional physics is definitely broader in its teaching than the PT curriculum. While PT emphasizes mechanical, fluidal, electrical, and thermal (CORD, 1992), traditional physics classes also teach these topics, but on a more advanced level (Serway and Faughn,
PT provides a base level of the technical aspects of physics with less theory, and more "working knowledge." If a student is looking for a physics class that is advanced math applicable, less hands on and more abstract, then the traditional physics class will best suit their needs. This statement leads us to the question: "Who is PT targeting, and are these individuals receiving a physics education that will help them reach their goals?"

Principles of Technology was originally developed for the middle 50% of the students attending high school. It is a course that uses applied concepts of physics and is not historical or theoretical to the extent of a traditional physics class. The reasoning behind this was that if you make a class more basic and hands-on you will touch more of the students who typically do not take Physics. The average student is more likely to succeed in this type of instruction because the material being covered seems more real life to them. What about the top 20% who normally take traditional physics classes? Do these students get the benefits they need to go on to college?

This question can best be answered through information from four different research papers on this topic. The first paper written by Baker, Wilmoth, and Lewis (1991) provided this conclusion:

Based on the data analysis, given a set of malleable student and teacher variables, it was concluded that Principles of Technology is a sound academic course, equivalent to physics, in terms of student performance on a test of physics (mechanics, heat, and electricity) items. Under that conclusion education counselors should not hesitate to encourage both college bound students (both 2 and 4 year) and students who will upon high school graduation immediately enter the engineering related technology/mechanical work force to enroll in Principles of Technology courses.

The data analyzed in this research were based upon testing of 226 students in PT and 306 students enrolled in a traditional physics course. The students all were separated into four quartile groups according to scores on the math section of the SAT. The 30 questions for the test were selectively chosen from the areas of mechanics, heat, and electricity from the NSTA/AAPT High School Physics Exam. Teachers were also a variable in this research and it was speculated in this paper that students in the lower quartile of math would have greater success with the teachers of more experience and physics background.

The second paper written by John Dugger an associate professor of industrial education and technology at Iowa State and David Johnson (1992), presented the results of a two year study comparing student performances in traditional physics classes with those taking the Principles of Technology modules 1-6 (first year). The study involved 675 high schools students in 15 Iowa school districts taking a pre-test and post-test composed of a 120 questions. These questions were developed around topics recognizable to both groups. The tests were submitted to a group of five secondary physics teachers and a community college physics teacher to review and ensure that the topics and terminology were presented in a typical high school physics class. In a summary of the results of the research Dugger stated:

All students took a pre-test to determine their physics knowledge before starting the Physics and PT courses. As expected, the physics students outscored the industrial education students by an average of five points. The test was re-administered after one year of Physics and PT instruction. PT students not only made up the initial five-point differential, but they outscored the physics students by an average of 11 points, a total swing of 17 points. The physics students gained 12 points while the PT students gained 29 points.

Dugger continued this research (Dugger and Meier, 1994) but this time tested students who had completed year 1 of PT and were currently enrolled in year 2 (modules 7-14) to compared with the physics students. This time the 120 test questions were derived from year 2 objectives in PT. Only 160 students and 3 sites were accountable for the data collected. Again the research saw the same results with PT and physics students making gains from pre-test to post-test, but the scores of the PT students were the highest in both percentage and improvement.

The last summary of research (Wang and Owens, 1995) constitutes the findings of a four year study, from 1990-1994, on applied academics. This study was conducted through Northwest Regional Educational Laboratory by contract from The Boeing Company. The purpose of the study was to see if the help the company was providing was having meaningful results at the schools in Washington state that were provided with assistance. The research of interest in this evaluation were the PT results and the student survey. The findings as summarized in the conclusion were:

Although PT comparison students appeared to score significantly higher at first glance, PT students were actually doing equally well and sometimes better when certain variables were kept constant, such as overall GPA and grades in
mathematics and science. Since more “low achievers” were enrolled in the PT classes than the traditional physics classes, test scores tended to skew in favor of PT comparison students when academic backgrounds were not controlled in analysis. The results of student surveys show that AM and PT students who were at the lower end of academic achievement tended to gain greatest in applied academics courses. They were also found to be more confident about their ability to learn mathematics and science.

Discussion

These papers are not suggesting that PT replace “all” traditional high school Physics classes. These traditional Physics classes are still very much needed for the upper 20% of students who have the ability to learn in these more historical and theoretical settings. What they are saying is that for the average student, PT seems to get the student to learn physics and also to take a course that might normally scare them away. In addition the traditional Physics student in a PT course learns enough of the core curriculum of physics to succeed in physics courses that relate to technology at the collegiate level. It is important for students to view PT as an alternate path, not an easy path to learn physics.

In closing I would like to present a personal perspective of Principles of Technology and my hopes of where it will lead the physics program in our High School. With the current positive perception of PT, by most, I can not help but be excited about this class. I feel this curriculum will finally help me teach those students who have been struggling to succeed in the previous physics class, and I also think that this course will offer the material needed by the advance student to hold their attention and prosper as well.

About the Author

Steve Wignall is a high school physics teacher in Seward, Nebraska, USA.

References

## Principles of Technology

### Four Week Presentation Strategy for One Technical Concept

(Figure 1)

<table>
<thead>
<tr>
<th>WEEK</th>
<th>MONDAY</th>
<th>TUESDAY</th>
<th>WEDNESDAY</th>
<th>THURSDAY</th>
<th>FRIDAY</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>WEEK 1</strong></td>
<td>5-Minute Video—Concept Intro</td>
<td>Hardware Demonstration on Mechanical Application of Concept</td>
<td>ProblemSolving (Math) Lab</td>
<td>Hands-on Lab—Mechanical Application of Concept</td>
<td>Hands-on Lab—Mechanical Application of Concept</td>
</tr>
<tr>
<td></td>
<td>7-Minute Video—Mechanical Application of Concept</td>
<td>Discussion</td>
<td></td>
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</tr>
<tr>
<td><strong>WEEK 2</strong></td>
<td>7-Minute Video—Fluidal Application of Concept</td>
<td>Hardware Demonstration on Fluidal Application of Concept</td>
<td>ProblemSolving (Math) Lab</td>
<td>Hands-on Lab—Fluidal Application of Concept</td>
<td>Hands-on Lab—Fluidal Application of Concept</td>
</tr>
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<td></td>
<td>Discussion</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>WEEK 3</strong></td>
<td>7-Minute Video—Electrical Application of Concept</td>
<td>Hardware Demonstration on Electrical Application of Concept</td>
<td>ProblemSolving (Math) Lab</td>
<td>Hands-on Lab—Electrical Application of Concept</td>
<td>Hands-on Lab—Electrical Application of Concept</td>
</tr>
<tr>
<td></td>
<td>Discussion</td>
<td>Discussion</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>WEEK 4</strong></td>
<td>7-Minute Video—Thermal Application of Concept</td>
<td>Hardware Demonstration on Thermal Application of Concept</td>
<td>ProblemSolving (Math) Lab</td>
<td>Hands-on Lab—Thermal Application of Concept</td>
<td>Hands-on Lab—Thermal Application of Concept</td>
</tr>
<tr>
<td></td>
<td>Discussion</td>
<td>Discussion</td>
<td></td>
<td>Video Review of Concept</td>
<td></td>
</tr>
</tbody>
</table>

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TURNING AN EVERYDAY EXPERIENCE INTO ONE OF LEARNING
SCIENCE—VISITS TO MUSEUMS AND ZOOS OF PRIMARY CHILDREN
AND FAMILIES

Sue Dale Tunnicliffe
Homerton College Cambridge England

A museum visit becomes a salient memory for life
but is more meaningful in terms of remembered content
if the exhibits are already familiar in some way to the
visitors (Falk and Dierking 1996), a crucial fact to be
borne in mind by educators, be they from the schools
of the pupils, or the educators of the wider audience of
the totality of the museum visitors—the designers,
museum educators and interpreters.

One of the main missions of zoos and to a lesser
extent museums is to inform and heighten the awareness
of the public about the conservations of endangered
species, however, families and primary school groups
are not interested if interest is measured by comments
about the topic (Tunnicliffe 1994). One of the main
missions of the school groups during field trips to zoos
and natural history museums should be to help their
pupils learn science, including conservation biology.

A field trip to a zoo or museum should provide
primary aged children with opportunities to use the
knowledge about animals that they have acquired in their
school science, indeed, when visits link with curriculum
topics already covered the pupil’s remember more
effectively (Wolins et al. 1992). Moreover, this
emphasis on particular content would be expected to
be heard in the conversations of these groups. A family
or other leisure type of visit also provides a similar
opportunity within which social dynamics are the
predominant feature (e.g. Rosenfeld 1980). The
accompanying adults, teachers and parents, can
reinforce existing and assist new learning for the children
or they may reinforce the everyday or basic
understanding of animals that they, and the children,
already possess.

Museum research has shown that visitors talk about
the exhibit when in front of it (McManus 1987;
Tunnicliffe 1996) and they talk about what they
observe—that which interests them. Falk and Dierking
(1992: 100) summarize this link of interest with
previous knowledge.

“Museum visitors must somehow perceive
information before they can store it in memory.
Under normal conditions, people pay attention to
things that interest them. Their interests are
determined by experiences, knowledge, and
feelings. This is a classic feedback loop: People
learn best those things that they already know about
and interest them, and people are interested in those
things they learn best.”

But in what topics are visitors interested when they
look at animals as exhibits? Can institutions use the
information to render exhibits more ‘accessible’ for their
visitors in terms of what is observed and commented
upon.

If Falk and Dierking are correct in their statement,
the content of the conversations of groups of visitors
should provide information about what is of interest to
the individuals at the exhibits. Such topics may not
necessarily be those about which the institution, the
producers, thought visitors, the consumer, would
comment and about which the message of inherent
within the exhibit is concerned. Moreover, that which
interests the visitors and attracts their attention is likely
to be that which visitors expect to see, those features
and attributes that are possessed by their model of an
animal. Thus we have the producers’ ideas and model
about which visitors attend but which may be at odds
with the actuality of what this large segment of visitors,
primary schools and families, do attend, if this is gauged
by the content of the conversations. Knowing the
content of the conversations is the starting point for the
producer in understanding the visitor’s interest and hence in designing effective exhibits, if that is defined by one whose message the visitors receive, translate and discuss.

Analysis of content of conversations at museum and zoo animals has shown that the content so similar, irrespective of the type and species of the animals, alive or preserved, and that there is surprisingly little difference between the content of that of primary school parties and family groups (Tunnicliffe 1995b) but that a museum is the site of preference to help children observe and develop ideas about animals (Tunnicliffe 1996).

This suggests that either families are very well prepared for their visit in terms of knowledge and understanding which they use to interpret the animals they see or that the primary schools are not making maximum educational use of the visits in terms of the children discussing the content of zoology or the science process.

Visitors hold a mental model of animals before they visit and which serves as the basis for their interpretation of the animal exhibits. What is their mental model of the animals?

**Figure 1**
The mental model of an animal held by school and family visitors

They have expectations that they see animals and that they will be able to provide a category or name for the animal and that they will be able to interpret the animal, name any parts of the body or behavior that catches their attention. They have an expectation that they will be able to both recognize the animals in broad terms and fit them into their existing sets of familiar animals. Data from a study of the content of conversations of primary groups and families at a animal specimens in different locations (Tunnicliffe 1995b) show that there is a model of animals held by the visitors and it is the salient features and behaviors that feature in the model and these are the topics about which the visitors comment. These groups of visitor do not focus on the criterial attributes used by zoologists (Tunnicliffe 1995a).

Comments about salient features and expected aspects of animals is not science, it is everyday commentary. Science is about making accurate observations and about raising hypotheses, constructing investigations that can test the hypothesis, observing, recording evaluating and communicating the findings (Lemke 1990) in other words, ‘talking science.’ I did not hear the type of conversation that would indicate these processes in action.

The results of the analysis of the content of conversations suggest that neither teachers and pupils from schools were particularly ‘talking science’ when undertaking these outings during school time, nor, not unsurprisingly, were families visiting for leisure reasons not educational ones, were heard to do so. It is not unreasonable to expect children to ‘talk science’ when visiting zoos and museums rather than ‘talking everyday’ in a pattern similar to that shown by families on a leisure outing.

Reading the transcripts showed that these groups were not talking science but they were making everyday observational commentaries. Typical comments were as follows, child: ‘Oh look, it’s a zebra,’ to which the adults might reply, ‘Yes, so it is,’ or say nothing. In a ‘talking science’ situation the adults would take this opportunity to ask the child why s/he thought the animal to be a zebra, what criterial attributes the specimens possessed that ‘made it a lion’ the children could have consolidated and extended their experiences and knowledge of grouping animals. However, such opportunities were never grasped by teachers any more than by parents, with school groups or families.

It is most frequently the children who start of the dialogue, as in the above comments where they made a statement or in a question, typically, ‘What is it?’ Such a reversal of the traditional teacher initiated dialogue is referred to as INVERSE TRIADIC DIALOGUE
(Tunnicliffe 1995b:387). Instead of giving the everyday name of the animal as happened in the transcripts I collected, the adults could ask the children what they thought it might be and encourage and help them to work out the features possessed by the animal and which matched those of other animals familiar to them. They could also work out which features were shared by a wide range of animals, such as hair or dry scales, and which were more specific to a few types. Children could use keys to allocate specimens to major groups. Such categorization requires careful observations.

Pupils in school are expected to hypothesise and then plan a course of action, collect results and evaluate their findings, teachers could encourage pupils to follow this same science process within the zoo or museum. If a child focused on the long legs of a bird, an ostrich for example, a ‘talking science’ question could be to ask whether all birds had long legs and the children could design and carry out their own investigation within the zoo or museum to find the answer. Alternately the children could investigate through first hand observations whether all long legged birds have large white plumes (feathers) and small wings not used in flying.

Museums on the one hand, their exhibit designers and educators, and the people, teachers and parents, who bring children to museums and zoos on the other, can both work towards turning a visit to the animal exhibits from that of an everyday commentary and observation experience to one of science learning.

It takes very little to invite visitors to look more closely and with interpretation beyond that of a glance and identification in everyday terms of a specimen. Provide almost instant labels about new aspects of the animals (McIntosh 1993). Create more permanent labels that are large labels and written with an invitational question—‘Can you see the very long tongue of the giraffe?’ for example or explain what the visitors is likely to think. For instance visitors often mistakenly refer to the Oryx as a ‘goat’ so at this type of animal tell the visitors that although it may look rather like a goat it is not, explain why and tell the conservation story in a few words. The visitors, the consumers, can focus the attention of their groups on the animals and on the invitational interpretation but they can also challenge the identification remarks made by children or instead of providing an identity for the animal to the children for an unknown animal, encourage the child to work out what the animal can be, not perhaps at the species level but at the family or order level.

A visit to the museums or zoo is a partnership event. The producer, the museum or zoo, works in partnership with the visitors, their consumers. The onus is on each party to participate in a partnership of observation and comment. The one to provide information in a way that is meaningful to the visitors, who in their turn need to actively work with their observations and the information they both bring with them and acquire to turn the visit form a series of everyday observations to those of science in which the science process is used.

References

“Education is not filling a bucket but lighting a fire.”

—William Butler Yeats
THE INFLUENCE OF TEACHER ATTITUDE UPON TEACHER EFFECTIVENESS: VIGNETTES IN ENVIRONMENTAL SCIENCE EDUCATION

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Abstract

Constructivist philosophies of teaching, currently in vogue in classrooms today, are the catalysts for designing curriculum with hands-on/minds-on discovery science. Many curriculum designers subscribe to the belief that any teacher can effectively teach this high activity curriculum. An oversight in this philosophy is the critical role of teachers’ attitudes in the classroom. This paper documents the process of the pilot project of the WETLANDS, an interdisciplinary environmental science curriculum that incorporates the discovery approach to learning. The vignettes included in this article illustrate the powerful influence of the teacher in the classroom.

Teachers in USA schools today work with culturally, ethnically, and racially diverse students. Teachers’ attitudes about students and student learning abilities affect their effectiveness in the classroom. “Decisions teachers make in response to their views of students and student abilities greatly influence the overall impact of their instruction” (Armstrong & Savage, 1994, p. 57). Usually, effective teachers believe in themselves, in what they teach, and that they can make a difference. Turner (1991) asserts that to be effective, teachers must create a place of belonging and have a clearly defined program for the students.

An oversight in curriculum development and the push toward national standards is not acknowledging the role of the teacher in the effectiveness of any curriculum. Yager (1991) reports that scientific educational research has focused more on students than on teachers. The teacher’s attitude is crucial to his or her effectiveness in the classroom and to the successful implementation of curriculum. What follows are pivotal glimpses into two science classrooms that emphasize the teacher’s role in the success of designing and delivering a new generation of curriculum.

The WETLANDS Pilot Project

Teachers, in collaboration with the Department of Education and under a 1993 grant from the Environmental Protection Agency, developed five environmental science distance learning units. These units focused on environmental education processes that enhanced students’ skills of critical thinking, problem solving, and decision making and encouraged students to become responsible and concerned citizens who are active in environmental issues in this nation. The units adopted a constructivist philosophy and included student initiation of ideas, students testing their own ideas, use of cooperative learning strategies, and collection of real evidence. Learning was to be an active process; “knowledge is not acquired passively” (Yager, 1991, p. 55).
In the broadest sense, the purposes of the units were to:

- model exemplary teaching methods using interdisciplinary strategies.
- highlight environmental projects being conducted across the nation.
- use current environmental issues and problems to motivate students to acquire scientific knowledge and investigation techniques.
- mobilize young people to work with others in their extended communities for purposes of monitoring their environments and taking actions to protect the local and global environment.
- use distance learning and telecomputing technologies to broaden the impact of environmental education.

The units reflect student-centered curriculum as opposed to teacher-centered curriculum. The focus shifted from teaching information to emphasizing learning processes. Significant improvements in the environmental science curriculum include the interdisciplinary nature of the units, the discovery approach to learning, and the networking of students across the nation (Collins & Pawloski, 1995).

The constructivist view demands a shift of patterns traditionally associated with teacher and student roles (Condon, Clyde, Kyle, & Hovda, 1993). Constructivist teaching is a complex process focused on active learning. WETLANDS pilot teachers could not stay in the classroom and lecture, but were required to set up cooperative learning situations, allow students to design their own research projects, take students on field trips, and quite frankly, be in charge of an active classroom full of 9th grade students. Pilot teachers had to “buy into” not only the design of the curriculum, but also the underlying philosophy.

During the pilot process, the WETLANDS project coordinators kept reflective journals, observed classroom and field settings, and held personal conversations and interviews with participants. (Complete results of the pilot project are reported in Collins & Romjue, 1995.) What became apparent during the pilot was that each coordinator saw a distinctly different educational setting. These classroom settings are written as closely as possible to the reality of each situation. The information in these vignettes illustrates the influence of teacher attitude upon of teacher effectiveness.

Vignette #1

The 9th grade Biology Honors class at Everly High School is one of the pilot schools for the Environmental Science Distance Learning Project. Ms. Sally Carlson, a graduate of the state university, taught the class and has been at this school for over 20 years. The classroom was empty except for the usual trappings of a Biology class. In about 5 minutes the bell would ring and hot, sweaty kids would come into the room to take seats at flat black tables. Bolted to the floor and facing the front of the room, the tables were in four rows, two students seated at each table.

The students came into the room talking with each other, laughing and chatting about the important events of their day. It was midmorning and some of them had been together 2 or 3 hours; there was a lot to say. Students took their seats without much persuasion.

Sally Carlson was a veteran teacher. Her dark hair was curly and beginning to show some gray. She was tall for a woman, almost 5'11” and medium build. Her complexion was somewhat ruddy and tanned from spending many hours outdoors, possibly at field trips to the nearby wildlife refuge. She enjoyed these field trips very much and “moon lighted” during the summer as a guide for groups interested in seeing the refuge. She had many tales to tell about close encounters with one form of wildlife or another. These topics kept reoccurring in the conversation as she spoke to her students.

The class is a mixture of both male and female students, predominately white with three African American and one Hispanic student. For the most part they are quiet, but do not seem particularly interested in what they are doing. According to the unit design, today’s assignment was to learn about topographic maps, each group is supposed to have its own set of maps and follow prescribed activities. They were to work in cooperative learning groups, each student with a particular role.

Sally begins the class by talking about the week’s schedule and what they can and cannot bring on the bus on Friday for the field trip. She tells them a little about the wildlife refuge where they will be going. There is some discussion about the poisonous snakes they might see and the possibility of seeing a wild fox. After Sally talks for about 25 minutes, she instructs the first of the four rows to go to the back of the room where she has set up one set of the topographic maps. The maps cover the same area as the refuge that they will visit on the field trip. The students are to locate 8 specific things on each half of the map and then to figure out what the symbols mean. Each of the groups takes a turn going to the back of the room while the others talk quietly at their seats during the activity. They finish early, so Sally talks to them some more about some of the work she’s done at the site and some of the people with whom she has worked. She points out that while others have gone on to become well known in
field biology, she has remained at school to teach them. She is definitely very knowledgeable about the flora and fauna that they are going to be seeing and talks about what is common and not common for the area.

Apparently some of the students are not interested any longer and they put their heads down on the tables, waiting for the bell so that they can rush out the door to their next class. When Sally stops talking, some of the students even get up from their chairs and go back by the door, waiting for the bell to ring. The bell rings and the class is quickly emptied.

Before I leave, we talk about the next day that is to be the first live broadcast. The teachers are to interact with the television teachers to get the “kinks” out of the telecommunication. Sally announced to me that Mr. Hooper would do the television “thing” and she was going to spend another day with the students on the topographic maps. She told me earlier in the month that she had never touched a computer and never would and that the technology was up to Mr. Hooper. The students were to do one other map assignment, but it appears as though they will skip it. I extend my thanks to Sally for allowing me to visit the class that day and arrange to meet them at 7:30 a.m. on Friday for the field trip.

I visited the class as they viewed one of the tapes from the video cast. Students were sitting around tables and watching a couple of TV screens. Many had their heads down on the tables and were silently watching the program. Sally talked during the program and told the class that the TV teachers were obviously not professionals, and that she could do just as well. After the program was over, they returned to their classroom. There was no attempt to process any of the activities that were shown on the broadcast. I found out later that the class only viewed about three or four of the total eight broadcasts and that they had only done a small portion of the activities. Sally lectured during the rest of the time and the students were to take notes. She was going to quiz them over those notes, so they needed to be good.

The Field Trip . . .

Mr. Hooper had arranged to have two older students go out with the group on the field trip to do photography and videotaping. I walked out to the bus area with the fellow who was to do the videotaping. He appeared to only know that he was to get them in action and a few other shots such as the sign at the entrance.

Sally got the students on the bus and began to take attendance. She joked with several of the students. While taking roll, one student did not answer when Sally called his name. Sally said that they couldn’t be lucky enough that he wasn’t going, and then the student said, “I’m here!” Sarcastically, Sally said that she hoped that the student would behave on the trip. She told the students to take notes about everything she said and other things they would see.

On the drive to the refuge, Sally pointed out flora and fauna along the way to me and would occasionally say something to the students. When we arrived, we went into a visitor center to watch a film. Sally talked throughout the film explaining specific points. The students were attentive and tried to take notes in the dark room.

When we left the visitor center, Sally told them again that whenever she spoke they were to take notes. She started talking as we drove down some of the paths and kept on talking until we came to a stop. One student asked her how they were going to see these birds if they had to write everything down, and she told him she had some good pictures back at the school where they could see the details. One African American girl asked Sally at least four times to show them where a turtle bit her. When we finally arrived at the site, she had the bus stop and started telling the details of the event. She hadn’t talked very long when the same girl blurted out, “Hey Ms. Carlson, what’s that bird over there?” Sally shortened her story, sat down beside me, and said, “She’s through listening to the story.”

When we got out of the bus the second time, Sally instructed the students where and how to put out the diatom collectors. One girl in shorts was bitten many times by mosquitoes and had large welts on her legs; from that point she and couple of others were uninterested in the trip. After a short hike to view a specific area, the group headed back to the bus. The students were beyond listening anymore because Sally told them they would eat and then go home right away. They hurried back to the bus and started to eat their lunch. When we got on board she talked to the black girl and asked her, “What do you have for lunch? Chittlins and neckbones?” She asked her this more than once. The girl didn’t respond. I’m not sure what triggered the next question to the other black girl behind her, but Sally said to her, “I see you got a seat by yourself and we white folks had to bunch up,” again no response. We arrived at the school in time for students to get to their regular buses and head for home.

One day I returned to visit class and found students looking at the diatom slides that had been broken and carefully put in place on the microscopes. Students had apparently not used the microscopes before and Sally told them not to move the slides. They were to draw what they saw and to go back to their desks after they sketched their slide. Students were then to try to identify their drawings from some books that Sally had provided. I later found out Sally had gone out to retrieve the diatom collectors but most of them were missing. The purpose
of the activity was to let students search the slides and make comparisons to discover what diversity might be at each of the sites. Like the earlier activity, students were more passive than active in the process.

Vignette #2

Tim Hoffman’s class is at the far end of the old part of the high school building. Holcomb High was built in the late 1960’s but has one wing that is relatively new; the elementary classes are located in that wing. Once inside the science classroom, I could see three students working, one washing test tubes—a girl about 15 years old with short brown hair and brown eyes. She smiled as I entered and went about her work. A boy about 14 years old, with reddish hair and freckles, was moving boxes to the corner of the room. The third youth was busy in the back of the room, but I couldn’t see what he was doing. I could see Tim working with papers at the front of the room. Tim was not a very tall man and was somewhat heavy for his build. He had short sandy blonde hair and always seemed to have a grin on his face. He greeted me when he heard me talk to the kids. I had never been in this room before, but I had known Tim previously and had known some of his students through their work on science fairs. The room was “alive” with animals and plants, equipment, charts and a couple of computers. We had only a few minutes to talk before students started coming into the room.

There seemed to be much excitement. I heard one girl talking to a tall boy about how they were to be the video crew on the field trip and that they needed to take some time today to plan which groups they would follow and who was going to do the talking to explain what was on the video. The tardy bell rang and everyone rushed to their seats. The tables grouped students so that four students could sit together. When I looked around the room, I could see that most of the students were of what appeared to be of northern European decent. There were a couple of kids who had Latino names and probably were from the few Mexican-American families in the area.

When Tim got up, in what would have been the side of the room in most classes, the students stopped their chattering and turned to watch what he was going to do. Apparently the class had spent some time learning how to sample and conduct specific water tests. They also were familiar with the general area of the marsh that they were going to study. Each group had their copies of the topographical map on the wall, with their group names written on the bottom. Remnants of pieces of styrofoam and glass slides to make diatom collectors were still on the lab desk in the back of the room.

Tim started to speak to the entire group now, and students started asking questions. It seems as if he had already divided them into groups, and each of the groups had volunteered to master one phase of the learning activities that were to take place at the marsh. The girl and tall boy and the other two at their table were to take both photographs and videotape of the activities. Another group was responsible for getting the canoe out to a specified site on the marsh to anchor the diatom collectors that everyone in the class had made. Other groups chose to take various chemical tests, soil samples, and complete a variety of other activities at the site. One group was to be in charge of communicating with the other schools on the Internet. Most of the students’ questions dealt with the mechanics of getting the equipment to and from the site, the time allowed for each of the activities, and how they were supposed to report their findings. One table had a computer on it and the students reported that they had made contact with at least four other schools and also with the TV teachers the day before. They seemed to be very proud that they had managed to make the software work in spite of their earlier problems. They had written and sent a description of their school and town to the other schools and were anxiously waiting to hear replies from them to find out about the other pilot schools. The kids were going to be “talking” via the Internet. The students had already participated in the first of the live TV broadcasts and were hoping that the rest of the schools could receive the broadcast during their class time too. In fact, their school had shifted its whole schedule so that they could participate “live” during the broadcasts.

After about 20 minutes, Janet King entered the room and smiled at the students. They all seemed to recognize her and smiled back. Janet was about 5’6” tall and of medium build. She was an attractive lady, probably about 38 years old. She went up to where Tim was standing and said she was sorry for being late. Tim said that was all right because they needed to clear up some of the science details and that had given them time to talk. Janet then turned to the class and asked them what questions they might have concerning the writing activities on the field trip. One student raised his hand and asked if they were to write about their feelings or just what they saw. They discussed it for awhile, and another student asked if they could just put what they were thinking on a cassette tape. Janet evidently knew the students quite well, and said that if that was easier for them, it would be just fine, she would help them put it in a written form when they got back. I think that this student might have had some sort of learning disability and this was his normal method of doing this type of work. It seemed as if we had just started, and the bell rang to change classes. I told Tim that I would see them on Friday for the field trip and hurried back to my car to another appointment.
The Field Trip

By the time we got off of the main road and through the dirt road leading to the water’s edge at the Mitchell Marsh, it was about a 45 minute drive from the school. We had quite a caravan: a bus, two vans (one pulling a canoe), and my car. When we got all of our things together, Tim gave each team leader final instructions and the groups took off in different directions to start their various tasks. One girl had forgotten to bring a jacket, so I went and got her one of my old sweatshirts. It was just chilly enough that you needed something to wear, plus there were more mosquitoes than one would like for a day-long field trip.

I watched four girls take the canoe and put it into the water. After they dawned their life jackets, they gathered up the diatom collectors and started off to place them around pre-selected sites on the marsh. As they left, I heard Tim yell, “Write when you get there,” and I heard them giggle and keep going. The mosquitoes were really thick, so some repellent appeared and seemed to help drive them away. One group of students had already started collecting water samples and had the nitrate water test kit out. Tim went over to them and another group nearby who were obviously starting to test for another chemical. I heard Tim talk with them as they went through the steps of the tests together. Tim bent down on his knees and showed them how to compare the colors on their samples with the indicators and then how to read the results. They had obviously done this in class but must have wanted some reassurance that they were doing it right.

Janet King was with another group. They were observing the shoreline and she was talking to them about how she wanted them to take a few minutes to sit quietly and just listen to the sounds and take in the different sights and smells, and then to start writing. She told one student that she was going to make a sign and rename the marsh “Mosquito Marsh.” They thought it was funny and went about their work. The camera crew moved from area to area taking pictures and video shots of everyone as they went about their work. When we broke for lunch, students were still not finished with their tasks. They asked how much time was left and Tim said that we were going to have to hurry if we were going to make it back in time for volleyball and football practice. We only spent about one more hour at the site before it was time to pack up and go back to school.

Back at school, the students gathered up their things and put them back in the classroom. There was much laughter and some new songs that they had learned during the day. Everyone had a great time. They told Tim, Janet, and me good-bye and off they went.

Discussion

The most critical impression from the classroom vignettes is that, even with the most innovative curriculum and advanced technology, the teacher makes the curriculum and the environment of the classroom “work” for the students. Thoughts that teachers have about the content and the students they are to teach influence the way in which they will teach (Hewson, Kerby, & Cook, 1995). School experience for students is firmly entrenched in interactions with teachers and influenced by teacher attitudes. Even with hands-on, constructivist curriculum, students can still be in the roles of passive learners.

Constructivist teaching is a complex cognitive process focused on active learning. For some teachers, the ability to change instructional methods may be too great of a burden to bear. For teachers who adapt well to new situations, the possibilities may be endless. Adaptive teachers seem to be more effective in successfully promoting educational encounters since teacher responsiveness is positively correlated with teacher behaviors and student outcomes (O’Keefe & Johnston, 1989). As seen in these two vignettes, curriculum relies heavily on teachers’ abilities to adapt and respond to new situations, as well as their attitudes toward the possibilities.

According to Rogers (1969) significant learning depends on attitudes that exist in the relationship between students and facilitators. Important is realness, valuing learners, and a climate of empathic understanding. Another factor is the spirited attitude of the teacher. “One of the most striking characteristics of the excellent teacher is enthusiasm for what he or she is teaching” (Ryan & Cooper, 1992, p. 474). No matter how “teacher-proof” the curriculum may appear, teachers are the key to success. The manner in which they approach teaching and the attitudes they have toward their students will influence whatever curriculum they use.

References


“Retreat to advance. Sometimes the most important and urgent thing we can do is get away to a peaceful and quiet place.”

—Anonymous

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SCIENCE CENTRES: BUILDING BRIDGES WITH TEACHERS

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Abstract
The interactive approach to learning science is as relevant to the classroom as it is to the science centre. We live in a time when we need to forge partnerships between both formal and informal education sectors if we are to meet the challenge of developing scientific and technological literacy for all. As well as being fascinating places for people of all ages to visit, science centres are becoming important places of inspiration and support for teachers in their quest for a curriculum which relates science to daily experience and a learning approach which engages the mind of the student. The National Science and Technology Centre in Australia is helping to enrich school curricula through ‘hands-on, minds-on’ interactive programs. This paper outlines ways in which the Centre is developing curriculum resources for schools and providing professional development and training for teachers. These programs observe certain ‘hands-on minds-on’ principles to enhance the effectiveness of learning in primary and secondary classrooms.

The Interactive Approach
During the 1980s, interactive approaches to learning began to attract more widespread attention among education researchers and teachers. An interactive approach to learning science, according to one group of science education researchers (Biddulph et al., 1986), has an emphasis on “identifying learners’ present ideas and interacting with them to help them to modify or extend their ideas... not... trying to get them to some predetermined knowledge goal, but of nudging their thinking as far as possible to enable them to make better sense of their world”.

At the same time, the rapid growth of science centres has produced an additional community of science communicators and educators developing exhibition and program experiences also defined as ‘interactive’. When visitors interact with hands-on exhibits and activities in science centres, they are able to test their understanding of ideas as they interact with phenomena and with each other.

When the physicist Frank Oppenheimer founded the Exploratorium in San Francisco, he felt concerned that people were becoming information rich and experience poor. He wrote (Oppenheimer, 1968):

On the whole, people have very little opportunity to have any direct experience with the separate elements of nature or technology. They watch ocean waves, but have never been shown how to observe the way waves pass through each other, bend around corners or bounce off cliffs. In a science museum, one can provide these direct experiences with the behaviour of light, sound and motion. One can set up these experiences in such a way that they not only generate, but partially satisfy curiosity. Science is not just a process of discovering and recording natural phenomena; it is a process which develops our ways of thinking about nature and which enables us to find the connections that simplify and at times enrich our comprehension and awareness of nature.

Duensing (1993b) reports that Oppenheimer saw a science centre to be like a forest of natural phenomena, a rich environment where visitors can explore on their own terms, linger where they choose, experiment as they please.

Schools, Science Centres and the Constructivist Approach

The growing amount of research supporting a constructivist model of learning is of interest not only to those involved in formal schooling, but also to informal education institutions such as science centres. Science centres provide exhibit experiences and other programs on the understanding that visitors bring with them great diversity in terms of their previous
knowledge and experience, their assumptions and their expectations, as well as their ways of thinking and learning.

Science centres expect this diversity and design their exhibits and programs accordingly—as open-ended opportunities which provide flexibility in the manner and level of investigations individuals and groups may wish to undertake. Some visitors will want to explore a phenomena in depth—and may find out things which were never intended by the designer! Others will spend only a few seconds with an activity before proceeding to another—rushing to experience as many activities as possible (albeit superficially) in the time they have.

Feher (1990), in an article about the role of interactive science museums in studying how people learn, refers to an excerpt from a Grade 4 textbook which states 'Light is energy that you can see. Light travels through space in the form of waves.' She goes on to relate how statements like this are abstract and uninteresting because '... there is nothing you can do with it. There's nothing to go home and try out. There's no experience of nature. The problem is endemic in our schools: teachers teach abstractions, definitions and explanations of phenomena that, for the most part, students have never explored, or, worse still, that students may not even know actually occur. If schools so often put the cart (explanations) before the horse (first-hand experience of natural phenomena), modern science museums reverse the process'. Science centres '... present natural phenomena in the form of exhibits that are interactive and manipulable, exhibits whose express purpose is to enable visitors to explore and experiment'.

There is a growing body of research into visitor behaviour at science centres. In the light of this research, more and more centres are re-thinking the exhibit experiences they offer in order to broaden their capacity to meet a wider variety of individual and group needs. If science centres are to be a community resource, they need to become places which cater for the sectors of that community—children, teenagers, adults, family groups, school students, people with little background knowledge of science, as well as scientists, science educators and those for whom science is a key part of their work.

In the design of exhibit-based and activity experiences in science centres, the social aspect of visits is an important consideration. School students as well as families often visit science centres with dual agendas—they seek enjoyment from their visit as well as an educational experience. Science centres are becoming more aware of the need to orient programs not just towards the children in such groups, but towards a cross-generational social unit, allowing for social interaction and the communication and experience of ideas at varying levels (McManus, 1993).

Visitors to science centres have an opportunity to test their understanding as they interact with science phenomena through exhibits and activities. From a constructivist point of view, learning involves constructing meanings by forming links between existing knowledge and new situations. As visitors interact with phenomena and with other people, they may encounter information which agrees with their past experience. In this case, the meanings are confirmed and become more strongly held. Alternatively, visitors may encounter information which does not agree with their past experience. They may choose to ignore or otherwise rationalise the new information so that their meanings remain intact, or they may choose to revise their understanding to incorporate the new information (Saunders, 1992). It is this latter outcome that educators, whether teachers in formal schools or staff in science centres, strive to promote. Their goal is to provide experiences for learners to test their understanding. And the more compelling they can make those experiences, the more likely learners will develop their understanding of the phenomena.

**Working With Learning Outcomes and Performance Standards**

With the widespread emergence of curriculum documents focusing on learning outcomes and performance standards, it is understandable that many teachers feel that the most important function of classroom activities is to achieve certain, pre-determined learning outcomes at certain stages of schooling. However, from a constructivist perspective of how students learn, this view is unrealistic. Learning outcome statements can be used to measure student performance but a more exciting option is to use them to measure learning growth. With a constructivist approach, learning outcomes take on a role as 'signposts' to indicate how learning is progressing.

More and more science centres are making use of school curriculum and learning outcome statements in order to develop programs and exhibitions which will better serve classroom teachers and their students. Many centres document how each exhibition and program can be used to support curriculum outcomes (ASTC Newsletter: Sep/Oct 1994).

In 1989 in Australia, the State, Territory and Commonwealth Ministers of Education endorsed a number of common and agreed national goals for schooling in Australia. Since then, statements have been produced for each identified area of learning—science is one area, technology is another—to provide a
framework for curriculum development by education systems and schools (Curriculum Corporation, 1994a). Statements provide an account of the learning area, outline its essential elements and describe a sequence for developing knowledge and skills. In addition, curriculum profiles have been developed for each learning area to assist in the improvement of teaching and learning and to provide a common language for reporting student achievement (Curriculum Corporation, 1994b). Profiles describe the progression of learning typically achieved by students during the compulsory years of schooling (Years 1-10). Profiles and statements are linked—profiles show the typical progression in achieving outcomes, while statements are a framework of what might be taught to achieve these outcomes.

One of the core philosophical positions of the statements and profiles is that effective teaching and learning involves the recognition that students construct their own understanding. This notion, among other aspects of the science statement and science profile, has prompted certain academic and business groups in Australia to challenge the implementation of these documents in most states without addressing the concerns of these groups. It is their view, as represented by Fletcher in an article presenting opposing positions on the statements and profiles (Fletcher & Lowe, 1993), that scientific knowledge is not constructed, but that it is reliable, public, international and free of cultural bias; they express concern that the statement and profile characterise science as 'a way of knowing' and that this implies that there are other 'ways of knowing' that can provide equally reliable understanding. In contrast, Lowe in the same article contends that 'school science has, all too often, given a misleading view of science as eternal truth' and that this approach has 'failed most of our young people by denying them the exciting experience of seeing how the process of scientific inquiry is relevant to their lives' (Fletcher & Lowe, 1993). Despite this debate, education systems throughout Australia are using the statements and profiles as a basis for developing their own systemic curriculum policies and documents.

Science Centres: Contributing to the Process of Reform in School Science

The interactions between science centres and their school communities provide direct and indirect opportunities to effect change in classroom practice. The role of science centres can quite literally be a laboratory or agent for change in school science and technology. Teachers are being stimulated to think beyond the recipe style curricula within their schools to consider the impact of interactive, hands-on experiences in a classroom climate which encourages students to test their ideas and to undertake open-ended exploration.

Various studies report that some teachers view science centres as their 'philosophical home' (ASTC, 1989). In contrast to most schools, science centres are rich in resources and experiences that encourage an approach to science learning that is compatible with a constructivist understanding of how students learn. These teachers, in their contact with science centres, are being challenged to develop new instructional approaches and new ways of relating to their students and to science; their teaching is becoming more hands-on, more student-centred, and more inquiry-oriented.

Learning in a science centre typically starts with exploration rather than explanation. The opposite tends to happen in schools where learning more typically starts with explanation. Duensing (1993b) describes the approach taken by the Exploratorium:

The way in which we develop exhibits is the same process we use to develop the museum's projects and programs. Prototyping is implicit in all of our exhibit and program idea development. If an idea is not intriguing; if it doesn't push us to ask questions or explore in greater depth, we generally reject it. Starting with exploration is a fundamentally different pedagogical perspective than starting with explanation . . . we try to create the shortest distance between the person and the phenomenon, presenting the idea in as rich a form as possible. The richness of the presentation enables physicists as well as young children to be involved . . .

Perhaps it is through a misunderstanding of the pedagogy of science centres, that there has been some concern as to whether such informal places should be taken seriously as a resource in a formal education sense. Tags such as 'fun science' and 'edutainment' are often used when describing science centres. This may seem appropriate in terms of marketing science centre programs to the general public but, when considering visits by school students, such tags prompt the question (usually from a formal education perspective) 'Do students learn anything?' Science centres have responded in various ways. In order to correct any image of 'mindless frivolity', some centres have promoted new 'tags' through the use of slogans such as 'playground for the mind' and 'hands-on minds-on' when describing their exhibition and program experiences.

Since science centre exhibit and activity programs have the capacity to accommodate a variety of visitor start points, experiences and learning outcomes, it is nonsense to try and evaluate the educational effect of an exhibition or program by asking questions such as 'In what year did Robert J. Van de Graaff build his first 'lightning' machine?' This is not an appropriate type of question to be asking in order to find out what learning
is taking place in science centres, and yet, some research efforts have succumbed to this approach.

Although many studies have reported gains in cognitive learning as outcomes of visits to science centres, such gains are not all that should be considered in deciding whether visits are beneficial (Rennie et al., 1993). For example, Price and Hein (1991) define ‘educationally effective programs as those in which products are not emphasised, inquiry is sparked, open-ended questions are generated, and students actively participate and appear involved.’

Science centres are in a particularly unique position to conduct research into how people (adults as well as children) learn as they interact with phenomena through their exhibits and other interactive programs (see for example, Feher, 1990). These research findings can be used not only to develop and refine exhibits and programs in science centres, but also to help teachers develop more effective learning experiences for their students.

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Notes
At the International Forum on Scientific and Technological Literacy for All, Paris, 5-10 July 1993, delegates focusing on the non-formal and informal development of scientific and technological literacy identified a number of agencies/activities which utilise non-formal and informal approaches, including: (a) out-of-school activities such as science and technology clubs, camps, fairs, olympiads and competitions; (b) the mass media utilising print, radio and television as a means of communication; (c) informal institutions such as science and technology centres and museums; (d) community-based programs as offered through health centres, technical training centres, etc. For the purposes of this paper, the author uses “informal” to refer to both “non-formal” and “informal” approaches to scientific and technological literacy.

About the Author
After 20 years as a teacher and administrator in the ACT school system, Brenton Honeyman joined Questacon – The National Science and Technology Centre in Canberra, Australia, as Manager of Education & School Programs. Brenton and his team coordinate a wide range of public and school programs across Australia.

Brenton’s career as a science educator includes a diverse range of positions and appointments, including President of the Australian Science Teachers
Association; Convenor of the World Conference on Science Education and the Quality of Life; and Editor of Science Education International. He has been recently elected as the President of ICASE, the International Council of Associations for Science Education, and is working with UNESCO and other international organisations on a worldwide project to enhance scientific and technological literacy for all.

His current interests include: broadening teaching learning repertoires so as to increase student engagement in learning, strategic planning in educational management, industry-education links, science communication, and international science education.

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**Surfing for a Good Home Page?**

There are hundreds of websites evolving on the Internet—many of these have great value for teachers and students alike. Here are some you’ll want to access or at least put on your bookmark for future reference.

http://www.nwf.org/kids/
This is the National Wildlife Federations FOR KIDS! section of their home page. It features a cool tour of conservation, riddles, games and more.

http://eelink.vmich.edu/wild/wildhome.html
Welcome to the Project WILD home page! A summary of everything that’s happening nationally with the Project WILD program.

http://www.ngpc.state.ne.us/
This is the Games and Parks home page which features all you ever wanted to know about Game and Parks. If your students use pictures or sounds of selected wildlife species, check out this home page. Plus lots, lot more including Project WILD in Nebraska.

http://www.fws.gov/
The US Fish and Wildlife Service provides a lot of information on species, issues, and programs.

http://www.wri.org/wri/nved
World Resources Institute offers information on global environmental issues, news on major events and trends.

www.discovery.com
The Discovery Channel’s home page for conservation-minded kids.

http://globe.fsl.noaa.gov/
Have classrooms from 20 countries participating in global ecology studies.

www.mbnet.mb.ca/eddy
Eddie the Ecodog rides the Internet teaching kids simple environmental lessons.

http://www.tnc.org
The Nature Conservancy’s page highlighting conservation projects and wildlife studies around the globe.
Book Announcement

Partnerships of Schools and Institutions of Higher Education in Teacher Development

Editors
Ron Hoz, Ben-Gurion University of the Negev, Israel
Moshe Silberstein, Tel-Aviv University, Israel

Editorial Board
Miriam Ben-Peretz, Haifa University, Israel
James Calderhead, University of Bath, U.K.
Naama Sabar Ben-Yehoshua, Tel-Aviv University, Israel
Pinchas Tamir, Hebrew University of Jerusalem, Israel

Ben-Gurion University of the Negev Press announces a new book in teacher development. The book contains three major sections with individual chapters written by a collection of authors.

Introduction—Ron Hoz

Improving Teacher Education through School-University Partnership
⇒ Integrating Knowledge and Beliefs: Promoting the Relevance of Educational Knowledge for Student Teachers—Harm H. Tilløma
⇒ The Professional Craft Knowledge of Teachers: Student Teachers Gaining Access to It—Sally Brown
⇒ Professional Development of Student Teachers during Preservice Training: A Follow-Up Study—Ruth Zuzovsky
⇒ Educating Teachers in Curriculum-Making: The Case of Conceptual Change—Moshe Silberstein
⇒ Who’s Teaching Whom? Learning Opportunities from Student Ethnographies—Stephen M. Ritchie
⇒ Helping Teachers Build Complex Conceptual Frameworks—Susan A. Adler
⇒ The Computer in Teacher Education—A Tool or a Partner?—Michal Ephratt
⇒ Teaching Internships: A Reflective Practice—William Kennedy, Clar Doyle, Andrea Rose & Amjit Singh
⇒ Teachers’ Perceptions of the Interplay between Theory and Practice in a Professional Development Context—Gabriella Minnes-Brandes
⇒ Alternative Certification in Special Education: Efficacy of a Collaborative, Field-Based Teacher Preparation Program—Elana E. Rock & Michael S. Rosenberg

Integrating Theory and Practice in Learning to Teach
⇒ Professionalism in Teaching: How to Save an Endangered Species—Theo Wubbels
⇒ Teacher Education as a Career-Long Process—Ralph Fessler
⇒ School Development through Teacher Development—Howard Bradley
⇒ Teaching Expertise: Theoretical Conceptualizations, Empirical Findings, and some Consequences for Teacher Training—F. E. Weinert & H. Lingelbach
⇒ Teacher Learning over Time: Accommodations, Reconceptualizations and Radical Transformations—Anna O. Soter
⇒ Mentoring in the Full Year Residence Practicum Internship Model—Batyra Bleicher & Ron Hoz
⇒ Unloosening Time for Teachers’ Professional Development—Jill Woodilla, Patt Dodds & Mary Lynn Boscardin

Teachers’ Professionalism and Its Advancement
⇒ Designing Educative Practicum Experiences for Prospective Teachers—Kenneth M. Zeichner
⇒ Professional Development Schools: Linking School Renewal and Teacher Education—Lynne Miller
⇒ Accointances, Partnerships and Illicit Affairs: Alternative Relationships in the Move toward School-Based Teacher Education—James Calderhead
⇒ Teacher Education and the Market Economy in Britain: The Teachers’ Views—Pam Poppleton

Epilogue—Michal Zellermayer
"Necessity is the mother of taking chances . . ."

—Mark Twain

Association for the Education of Teachers in Science
AETS Monograph

Science Teacher Preparation: An International Perspective

CALL FOR PAPERS

The Association for the Education of Teachers in Science (AETS) is sponsoring a call for papers for a monograph concerning international perspectives on Science Teacher Preparation. Papers relating to policies and perspectives driving elementary and secondary science teacher preparation programs worldwide are encouraged. Papers should highlight the cultural, historical, and theoretical contexts for science teacher preparation, describe research findings, and/or describe specific practices.

Timeline:

December 30, 1996 Paper proposals (maximum 3 pages) due
February 15, 1997 Letters of acceptance sent
July 30, 1997 Manuscripts due
October 15, 1997 Editorial review completed
December 30, 1997 Revisions due
Summer 1998 Expected publication

If you are interested in contributing to this volume, would like information about proposal format, or have further questions, please contact:

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**Book Review**

Teaching Ethical Aspects of Science

Edited by
Patrick Fullick and Mary Ratcliffe
for
The Science, Ethics and Education Project
Published by the Bassett Press

This book review has been prepared by Donna Hare, University of Nebraska.

The teaching of ethical aspects of science are being addressed internationally by such efforts as Science, Technology and Society, Issue Science, Scientific Literacy, Science and Technology Education and Future Human Needs, the Harare Generator, Education for Global Change, as well as Project 2000+. At the basis of this issue-oriented trend lie deep concerns in three basic contexts:

- Science—what we can do
- Sociocultural—what we need to do
- Ethical—what we ought to do

The book, Teaching Ethical Aspects of Science, edited by Patrick Fullick and Mary Ratcliffe as part of the Science, Ethics and Education Project and published by The Bassett Press, addresses these concerns in a thorough, logical, practical and versatile manner.

The approach begins with a clear delineation of general purposes and guidelines relevant to content, structure and processes incorporated in a program intended to facilitate the exploration of ethics in scientific endeavor.

The authors propose as a principle of ethical education that, “students have a right to address science-related issues which may affect their future lives,” p. 11, and that as a consequence, teachers have the duty to:

- encourage respect for rational inquiry using logical thinking and a variety of relevant evidence;
- encourage open-mindedness, a willingness to listen to and respect the points of view of others, and to avoid haste in judgment;
- encourage an awareness of similarities and differences in ethical interpretations of science-based issues, and
- avoid indoctrination, p. 11

This clarification of purposes is followed by a very practical, detailed yet concise basic primer introducing the potential user to the field of ethical inquiry and concern: from psychological egoism, to Kant, to Rawls. The next section provides the reader with a pragmatic explanation of, “... how these principles of ethics and ethical analysis can be used to produce effective teaching and learning strategies,” p. 21. The basic learning strategies to be utilized include:

- Consequence mapping;
- Structured decision-making: cost/benefit analysis
- Structured analysis of people’s actions using a “Goals, Rights and Duties” model;
- Focused questions, p. 21

A model for the presentation of this approach is then offered. The proposed model is based upon a series of case studies which constitute the bulk volume of the writing. The authors have included a very “friendly” table (p. 36) which summarizes the case studies offered by title, issue, ethics focus, science focus, learning approaches, and prior knowledge required for students. Some problems arise in the level of difficulty selected by the authors which is evident in the selected case studies. The reading level alone might discourage the classroom practitioner from attempting the incorporation of this approach. But this also points out one of the major strengths of this particular offering. The authors have made an obvious effort to keep the presentation of their proposed approach open-ended, versatile and adaptable. The case studies, which include basic lesson outlines, are offered strictly as models which may be adapted, replicated or replaced to accommodate the individual practitioner’s classroom needs. This publication is contributed not strictly as an overall program of instruction (though it could certainly stand alone as the basis of a focused course of study), but rather as a useful and versatile educational tool which wise practitioners may add to their personal repertoires. Such a presentation elicits a flood of ideas and possibilities for incorporation with highly compatible formats like Multiple Intelligences; Scope, Sequence and Coordination; Action Research; Science,
Sequence and Coordination; Action Research; Science, Technology and Society; Multi-discipline Education; Multi-Culturalism; as well as other more traditional programs of study.

Teaching Ethical Aspects of Science is a well organized thorough, practical, teacher-friendly, and significant offering with great potential for a broad spectrum of science educators. I recommend this innovative tool to my fellow practitioners as an additional element to meaningfully link and extend various approaches they may currently be applying, as well as a catalyst to revitalize and redirect their persistent efforts to provide today’s science students with the vital understandings they will need to carry on the functions of citizenry and to perpetuate a productive, principled, and humane society.

"If you want to truly understand something, try to change it . . . ."

—Kurt Lewin

British Council International Seminar
(Number 9679)

Technology education in the core curriculum

12 to 19 March 1997

Directed by Professor Paul Black and Mr Justin Dillon

The seminar will explore different rationale for technology education in the school curriculum, and the traditions from which they arise in different countries.

Main themes will include:

- a comparison of technology curricula in different countries
- the purpose of technology as a school subject, eg technology and environment, technology and society
- classroom implementation and curriculum material

The programme will be of particular interest to those responsible for curriculum development and teacher training.

Fee: £1,750 (residential)

For further information contact: Promotions Manager, International Seminars Department, The British Council, 1 Beaumont Place, Oxford OX1 2PJ.
Telephone: +44(0) 1865 311636. Fax: +44(0) 1865 557368 / 516590. E-mail: international.seminars@britcoun.org

(Programme details are subject to amendment. For a full prospectus please contact Promotions Manager, quoting the seminar number in all correspondence.)
Calendar
1996-1997

20-23 December, 1996
The Second Scientific Conference on The Future of Science and Mathematics Teaching and the Needs of Arab Society
University of Science, Technology and Medicine in Tunisia (Tunis 2)

Conference coordinator:
Mohamad Debs
Arab Development Institute
P.O. Box 14-5300, Beirut, Lebanon
Fax 01-212-4782932
email: cnrs10@calvacom.fr

For contact with the Organising Committee in Tunisia:
Ahmad BouAzzi
Fax 216-1-510729

27-30 December, 1996
NSTA International Convention

This convention, to be held in San Francisco, USA is intended to bring together scientists, school and college science educators and science education organisations worldwide.

For further information contact:
NSTA headquarters
1840 Wilson Boulevard
Arlington, VA 22201-3000, USA.

2-5 January 1997
The First Mediterranean Conference Mathematics—Education and Applications
Latsia, Nicosia, Cyprus
Tel/Fax: +31-880-3100
email: langm@ipn.uni-kiel.de

6-9 January, 1997
International Conference on Science, Mathematics and Technology Education
Hanoi, Vietnam

Contact:
Thao Le, University of Tasmania
email: T.Le@educ.utas.edu.au

6-10 April, 1997
10th ICASE Asian Symposium

This symposium will be held in Lahore, Pakistan with the theme “Empowering teachers to promote scientific and technological literacy for all in the 21st century.”

For further details please contact:
Dr. Hafiz Muhammad. Iqbal
IER, University of the Punjab
New Campus, Lahore, Post code 54590, Pakistan

22-26 April, 1997
Second ICASE Latin American symposium
(held at Mar del Plata, Argentina and hosted by Club de Ciencias Albert Einstein)

For further information and to be put on the mailing list, contact:
Prof. Marta Moyano, Secretariat
Club de Ciencias “Albert Einstein”
Salta 2857 Planta Alta
(7600) Mar del Plata
Argentina
Tel/fax: 54 23 74 9556
email: retait@uni-mdp.edu.ar

25-30 August, 1997
Seventh European conference for Research on Learning and Instruction

The Theme for the symposium is: “To Improve Scientific and Technological Education for All: A Challenge for the Year 2000 and Beyond.”

Contact Addresses:
Scientific Programme Secretariat:
Stella Vosniadou, Professor of Psychology
Tel/ Fax.: 3640719 (Athens, Greece)
email: svosniad@atlas.uoa.ariadne.t.gr

Conference Organising Bureau:
Erasmus Horizon Ltd.
Tel.: 7257531, 7257693 5 (Athens, Greece)
Fax.: 7257532
CONASTA 46
Annual Meeting of the Australian Science Teachers Association
June 29-July 4, 1997
University of Melbourne

The Theme
Science Down Under—Extending the Boundaries’ Our aim is to provide science teachers
with up-to-date cutting edge information on the thinking of Australian scientists and near
neighbours. The programme will also highlight practice and theory suitable for all levels of
science education. It is our intention to extend the boundaries of knowledge.

Exhibitions
Throughout CONASTA 46 there will be extensive displays and showcases of science
resources, videos, computer software, laboratory apparatus and curriculum materials.

Excursions
A full range of social and informative excursions are being planned to enhance the program.
A special Sunday welcome function is being organised, along with a Conference Dinner
featuring a mystery tour. A post-conference excursion programme will be available.

Registration
The registration brochure will be available later this year and will be sent to all members of
the Australian Science Teachers’ Association. Initial expressions of interest can be filled in
on the back of this brochure.

Travel
Qantas has been appointed the official airline for the conference and will be offering discounted
conference airfares for conference delegates and accompanying persons. Full details will be
included in the registration brochure.

The hard copy of your abstract should be submitted by November 1, 1996. Further information
will be required by the STAV Secretariat as soon as practical after this date.

Presenters will be notified of their acceptance of Workshops/Seminars and all presenters are
required to register for the Conference.

For more information contact:

Science Teachers’ Association of Victoria,
PO Box 190, Richmond, 3121
Tel. (03) 9428 2633, Fax. (03) 9428 4876
Email: stav@netspace.net.au
Extending and Improving Education in Science for All Children and Youth by Assisting Member Associations Throughout the World

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Science Education International is the Quarterly Journal of the International Council of Associations for Science Education. ICASE was established in 1973 to extend and improve education in science for all children and youth by assisting member associations throughout the world.

This journal provides a means for associations, institutions, centres, foundations, companies and individuals concerned with science education, to share perspectives, concerns, ideas, and information which will foster cooperative efforts to improve science education, and which will serve as a chronicle of the advancement of science education throughout the world.

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March 1 February
June 1 May
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December 1 November

ICASE News ........................................... 2
Feature Article ...................................... 3
Science Education Around the World .......... 8
Research on Curriculum, Teaching & Learning ........................................... 16
Teaching Materials & Strategies ............... 22
Science Teacher Education & Leadership .... 28
Resources ............................................. 34
Calendar ............................................. 38

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Educational Research in Chemistry and Physics Education

The 5th international symposium on science education research was organised in the University of Dortmund by Prof Hans-Jurgen Schmidt in May 1996.

This series of symposia has become well known among science educators and researchers, as offering an insight into the relationship between research and teaching. ICASE has been involved with all the symposia having published the proceedings each time for wider dissemination among ICASE members and more widely.

The programme for this symposium included papers from researchers from many countries, within and outside Europe, including two significant papers from Taiwan and one from Mozambique. The proceedings will be available early in 1997 from ICASE; details will appear in this Journal.

This symposium is the last in the series to be held in Dortmund because the initiator and organiser, Hans-Jurgen Schmidt, will be retiring from his post in the University before the next symposium is due in 1998. ICASE has already recognised the contributions that Hans-Jurgen Schmidt has made to international science education by awarding him, in 1995, the ICASE Certificate for Excellence in International Science Education, and would like to pay special tribute to his work in Dortmund for this series of symposia. The next symposium will be held in Utrecht in 1998, and will be organised by Dr. Otto de Jong, a regular participant in the Dortmund symposia. Details of this symposium will be available to all interested researchers and will be announced in the columns of the ICASE Journal in due course.

New Institution Member

Children & Youth Science Centre of China Association for Science & Technology is a non-formal science and technology education institution under the CAST. The objective of the Centre is to promote youth in China understanding of science and technology, and enhance the scientific and technological literacy of the young generation, no matter urban or rural, male or female, through various means of scientific and technological activities.

Children & Youth Science Centre of CAST considers that its objective is similar with the aim of ICASE, “to extend and improve education in science and technology for all children and youth throughout the world,” and is willing to join in the Organization so as to share the information and experiences with other members, and make its contribution to the development of science and technology education world-wide.

ICASE would like to welcome our new member and look forward to their involvement in 2000+ and other ICASE programmes.
CREATING EXEMPLARY TEACHING MATERIALS TO ENHANCE SCIENTIFIC AND TECHNOLOGICAL LITERACY

Jack Holbrook
Executive Secretary, ICASE
and
Miia Rannikmae
University of Tartu, Estonia

Abstract

A workshop was organized to create teaching materials that met stipulated criteria and was used to guide participants to run similar workshops of their own at a national or sub-national level. The reason for promoting such teaching materials was to enhance the teaching of science subjects in the direction promoted by Project 2000— a UNESCO/ICASE initiative to enhance scientific and technological literacy for all. This article sets out to explain the need for scientific and technological literacy, the role of supplementary teaching material specifically created for this purpose and the successes and difficulties in creating STL teaching material in a workshop.

Introduction

Today science and technology invade all our lives. The quality of our life is highly dependent on the technology we use and hence the scientific developments to which they relate. In the future, science and technology can be predicted to invade our lives to an even greater extent, bringing us in contact with more and more scientifically related choices. Not only are we likely to make an increasing number of scientific and technological decisions, but we will need a greater ability to cope with change. This does not simply apply to a few citizens who wish to follow particular careers. It applies to all of us.

It appears that a crucial need for all citizens in the 21st century is the ability to interact with scientific and technological choices and make scientific and technological decisions. If this can be described as a facet of literacy, in the scientific and technological sense, then scientific and technological literacy is a future need for everyone. And what is more, the higher the education level a student receives, the greater the literacy level to be attained. Just as illiteracy in terms of reading and writing leads to social disadvantages, the same can be said, in the future, for illiteracy in terms of science and technology.

If scientific and technological literacy is crucial, as proposed above, what can schools do to promote this? After all schools, by large, are charged with satisfying the educational needs of children who will be the adults of tomorrow. These needs are often expressed as educational goals (see Table 1) and for schools these are usually stipulated by the society and formulated by the Minister of Education. The educational goals signify the curriculum intention and may often be expressed in terms of

a) intellectual development, e.g., ability to think conceptually; develop creative, critical and analytical thinking and the ability to make rational and independent decisions.
b) personal attributes, e.g., promoting of mental and physical health, cultural and recreational interests
c) societal attributes, e.g., identifying and cultivating personal ethical values, a concern for the community, to develop social skills, leadership qualities and a sense of responsibility
d) communication, e.g., to foster an ability to communicate using verbal, written, tabular, symbolic or graphical forms

Table 1. Education Goals: a typical example
(This version was produced by the curriculum development committee in Hong Kong)

1. Help pupils to cultivate their moral and social values, to make critical value judgements and to develop an ability to solve value conflicts;
2. Promote pupils’ mental and physical health and to encourage worthy use of leisure;
3. Nurture pupils’ creativity and to promote their aesthetic development;
4. Help pupils to develop their ability to think logically and independently and to make rational decisions;
5. Help pupils to develop a positive attitude towards life and a sense of responsibility for their roles in the family and the community;
6. Help pupils to develop their ability to communicate effectively in both Chinese and English in relation
to the different roles that each language plays in the Hong Kong community;
7. Provide pupils with a basis of mathematical, scientific, technical and commercial knowledge and skills to prepare them for the fast-changing, highly technological society in which they live and work;
8. Help pupils to develop their potential for further study or work according to their ability and aptitude;
9. Help pupils to acquire an appreciation of the Chinese culture and develop respect for all peoples, their cultures, values and ways of life;
10. Encourage pupils to develop a respect, awareness and concern for the local environment, their society, China and the world; and
11. Help pupils to understand and adapt to the unique situation of Hong Kong—its cultural, social, economic and political characteristics.

I hope you agree that Table 1 represents a good set of aims for education, even though they are presented in a very broad manner and in some places, are specific to Hong Kong. Schools attempt to achieve these educational goals by instruction within school disciplines. Thus science, being on the school timetable in some form, is one subject area through which the educational goals are to be achieved. Science education is thus about achieving educational goals through a context of science. This is put forward as a very important deviation from the traditional goals of science education that are seen as putting forward science education as simply a body of knowledge.

These goals represent the intention. It is the target. Education was never intended as rote memory of isolated facts. But that is how it ends up in many situations. Faced with this, the question is not ‘what are the intentions,’ but rather ‘how do we implement them?’ This is a major problem. Worldwide education have based implementation on 19th century logic and sub-divided teaching into content areas, called subjects. And we are given no guidance as to which educational goals are to be achieved in each subject area. Each subject area, seemingly independently, puts forward its own set of objectives. Until such time as we are ready to influence education en masse, or to operate in a more societal framework, e.g., teaching divisions based on the environment, ethics and social responsibility, etc., let us confine this article to the realm of science education, i.e., the subject called science on the school timetable.

Project 2000+ suggests the one and only goal of science education is to enhance scientific and technological literacy for all (STL) (UNESCO, 1994). This literacy, in line with the earlier educational goals, has intellectual, personal, societal and communication aspects and hence all these aspects need to form part of a science course. Note that content is not mentioned, meaning that content, in itself as something to study in isolated from the educational goals mentioned, is unimportant. It should not be the starting point, nor the prime rationale, for teaching. It is with regard to this lack of importance of any specific, isolated, science content that Project 2000+ begins to introduce the need for a radical rethink of the purpose of science education for the classroom teacher. Science teachers teach students, not science!!

In studying the development of scientific and technological literacy for all, research has shown:

1. The context is more important than the content. It is impossible to cover all science and technology knowledge. Whatever we do we can only cover an extremely small part. All we can do is touch upon the big ‘ideas.’ In doing so, research suggests that the context in which this is done is important. The more the context is ‘real,’ i.e., related to the society, the more motivation enhances achievement.

2. Constructivist approaches are important. We learn by making constructs. These constructs can be reinforced and enlarged or developed by appropriate stimuli. These stimuli can come from self learning, or with the help of others, i.e., teachers. However, it appears that it not possible to give someone ‘the construct.’ For example, we cannot give the full construct that enables us to have a concept of a chair. Only the students can do this. We, as teachers, can only guide. And this has very, very great implications as it means that we need to build on students’ prior constructs. We need to recognize students previous experiences. And then we need to give additional experiences that build and extend on those previously acquired. If we don’t, we could lead to alternative ‘frameworks,’ or misconceptions.

3. Learning is enhanced if the teacher is a facilitator, rather than the centre of wisdom—a giver of knowledge. Students learn when they are involved. Passive listening is at best part of a theoretical approach that allows precious little time for construct formation. And to cap this, it is important to realize that teachers saying ‘I must finish the syllabus’ has little meaning—it is the student that needs to be the centre of attention. What the teacher is or is not able to do, is far from our area of concern. Students need time for constructing information. Some students will need more time than others and all will need less time if previous experiences can be brought to bear.
4. Feedback is crucial. Both the student and the teacher benefit by being aware of the learning taking place and the steps needed to reinforce and enhance this. The greater the feedback by students, the more this can help students to realize their gains and the more the teacher can decide on the next stimuli for learning. Feedback thus enables the educational process to follow a non-linear model, designed to give maximum benefit to all students. Feedback reduces the need for such linear resources as a textbook which has limited educational benefits. But, whatever the approach, resources (appropriate to the educational goals) will be important to enhance the feedback activities.

Based on such findings, it would seem that much science teaching today is inappropriate. It is not designed to promote literacy. It is not designed to help students become responsible and decision making adults of tomorrow. There is a need for change.

One resource which can guide science education towards greater relevancy for the 21st century is the use of STL supplementary teaching materials. These materials are not extensions of the textbook, but are additional resources for the teacher to call upon as required. As such they are optional materials and can be used as and when the teacher feels it appropriate. The materials are based on the belief that, if the materials allow students to engage in activities relevant to STL, they enhance the learning situation and hence guide students to achieve the intended educational goals. So what supplementary materials are needed for STL teaching in the classroom or laboratory?

An important component of any science teaching for a good learning environment is that it needs to be interesting and enjoyable. Interest is governed by two important considerations—relevance and motivation. This also applies to teaching materials. Teaching materials that are relevant and motivational are likely to be found interesting by students.

Thus one challenge we face within Project 2000+ is how to make science education and its teaching materials relevant. Here we consider a change of thinking. We suggest, and this is supported by research, that relevant science education is that which relates to issues or concerns within the society. This could relate to the environment, the home, to do with health, energy needs, population control, industry, communication or to more global concerns geared to global warming. In fact it is no wonder that courses developed around this approach have been labelled STS—science, technology, society. However the philosophy of STS paralleling STL is perhaps better described as [society —> technology —> science] as this approach makes the relevancy overt. It also marks a major differences with science teaching in a science concept/fundamental approach. In a fundamental approach, science is the major starting, or relevant focus and the technological or societal aspects are the add-ons, the applications. At the very heart of Project 2000+ philosophy is that relevancy relates, for students in general, to society, not to science per se. This is a major paradigm shift.

A Project 2000+ approach calls for a resequencing in the teaching of topics in the science and technology curriculum. Research has shown that students construct their own conceptual understanding. This is based on prior learning, often coming from an out-of-school situation. In a Project 2000+ approach, the task is how to introduce scientific ideas which are considered important, and which sometimes may challenge the prior naive ideas held by students. The primary purpose of this is to guide students to solve problems or confront issues within which scientific conceptual ideas can play a role. Note I have not said solve a scientific problem, nor confront a scientific concept. These are but parts of the wider area of relevance embedded in the society. It is thus societal problems and issues that are relevant and science education guides students to utilize scientific understanding in tackling the issue, a factor lacking in conventional teaching approaches.

The philosophy thus proposed is that scientific and technological literacy for all is achieved through approaches in which students participation is pivotal. It is suggested there is a need to develop teaching materials geared to this philosophy. For simplicity, at this stage, it is proposed that the material relate to just one teaching lesson so that it does not confront curriculum issues. Also for simplicity, the materials is proposed as being supplementary, meaning that the teacher has a choice as to whether it is, or is not, used in the teaching situation.

Such teaching materials need, however, to meet certain criteria if they are to be considered STL. As far as we are aware these criteria have not been specifically identified in the literature and with this in mind the following are put forward for discussions and debate (Table 2).

Table 2. Criteria for creating exemplary STL materials

A) education goals are stipulated and form the major focus of the material, i.e. students are participating in the process of educational learning appropriate for the goals of the country and their intellectual development:
B) material is societally related, i.e., students are familiar with the situation and can thus appreciate its relevance;
C) following the material is a learning exercise, i.e., it provides an intellectual challenge and utilizes constructivist principles—moving from the information and understanding already in the possession of students to the new;
D) the activity is student participatory, i.e., the student is involved either individually or in groups for a considerable amount (>60%) of the teaching time;
E) consideration is given to enhancing a wide range of communication skills.

How is the creation of supplementary teaching material achieved? It is suggested that the teacher start from an issue or concern arising in the students societal perspective. This could arise from a student question (often a situation at the primary school level) to a topical concern being expressed in the media (the newspaper, television, radio). Then the skill is to determine an activity (or activities) that could best help students to appreciate the concern or issues in an educational perspective, gain the necessary scientific background and give appropriate feedback to show their grasp of the situation and their command of a communication skill relevant to the teaching situation.

An approach adopted in Eastern Europe was to run a 4 day workshop, and in which introduce the STL philosophy and following the use of exemplars, allow the participants to create teaching materials themselves. The workshop, held in May 1996, was funded by UNESCO (PROCEED—Programmes for Central and Eastern Europe Development, and STE—Science and Technology Education Unit of the Education Sector). The participants for the workshop were invited from 9 different Eastern European countries. As the invitation was sent through NGO channels, it was predictable that the participants were teachers or persons linked with teaching at school. This was the intention as the organizers we interested as to whether ordinary teachers could create STL teaching materials.

Through earlier communication, participants were motivation to collect data related to teaching science in social context (this was to be the base for the teaching material created during the workshop). The first day of the workshop was taken up with introducing the STL philosophy and allowing discussion on its implication for teaching. (The discussion was also intended to help participants appreciate how much they accepted the STL philosophy proposed earlier.) The second day was taken up with an extensive look at exemplars of STL teaching materials, whilst the rest of the time was used for creating their own teaching materials in groups and in presenting this to others.

The workshop had three main goals:

1. To discuss the meaning of STL and how teachers can implement this in practical and interesting ways.
2. Develop STL teaching materials and enhance the participant's ability to follow up this workshop with further similar workshops in their own countries using the national language.
3. To find out how the participant's way of understanding STL changed during the workshop and which were the most difficult problems in writing STL materials.

During the workshop it soon became very clear that teachers did not understand the notion of relating their teaching to the social context and the following aspects were noted:

1. In spite of instructions to collect industrial or commercial data, most participants had only fragments of information on possible utilization of science in everyday life.
2. In getting familiar with the new philosophy, the participants felt uncertain about developing an idea so as to produce STL material.
3. Participants needed to get feedback from the resource persons to confirm acceptance of their chosen problem before they would proceed.
4. The most popular area of problem investigation was related to environmental issues—this being one social context with which participants could easily identify.
5. The participants found it difficult to give attractive titles to their scripts.
6. The titles were kept rather more descriptive than highlighting a problem or issue.

To illustrate the types of changes that were suggested by the resource persons, Table 3 illustrates the titles of the first version of the scripts created by the participants and also the modified title as a result of further development. Beside developing an interesting title, it was very important to introduce the teaching idea in a social context for the learner. Here the participants had many problems. The influence of their current teaching was so powerful that the starting point in virtually all cases was the science.

Usually in their initial version, the participants tried to find wide social applications for common science issues. For example, the sculpture script began with a
consideration of corrosion and this was illustrated by beautiful sculptures in St. Petersburg. Destruction of the sculpture really is a social problem in St. Petersburg, but the introduction did not put it that way.

In due course the various scenarios took the format 'from society to science.' The new starting point for the sculpture script became dealing with the problem that sculptures have changed their bronze colour and were pitted with holes.

The need for student participation was well described in most scripts as participants seems to understand the need for this much better. And it was possible to find a wide range of students involvement ideas. The participants in fact attempted to use role-playing, problem solving strategies and brainstorming sessions in their scripts as well as experimental situations which seemed to indicate they had understood the need for developing communication skills among the students. It would appear that participants, at least in the workshop environment, appreciated the importance of active learning (the participants had themselves been put in a participatory comments and acceptance. To arrive at the final version for trials, the scripts in fact needed to be modify twice. The workshop confirmed the need for similar ones to be initiated by participants in their own countries. By being involved in the developing process, the participants could understand the philosophy behind Project 2000+ and the need for follow up being the only way to introduce a wider number of teachers to the new teaching methodology. The difficulties that arose during the workshop indicated the following weak points in the teaching process in Eastern Europe:

1. Setting up educational goals in such a way that the motivation comes from the society.
2. Overlooking the students activities and involvement for the lesson. The more conceptual objectives the teacher can cover in the lesson, the more perfect the lesson.
3. Setting out the teaching strategy in such a manner that all the objectives could be achieved.

One possible way to improve teaching as described above is to run writing workshops which help teachers

Table 3. The initial and developed titles for the STL scripts

| 1. Dynamics of population development | An investigation of the best conditions for butterfly capture |
| 2. Phosphorus circle in nature | Discovering old settlement sites |
| 3. Corrosion of sculptures | Problems of sculptures in cities |
| 4. Role of Wood Today and in the Future | Wood—a potential fuel for tomorrow |
| 5. Combustion products of different fuels and their influence on environment | Is emulsion suitable as an alternative fuel? |
| 6. How do you heat your home? | (to be decided) |
| 7. Radon in our houses | Radon in our homes—is risk acceptable? |
| 8. Investigation of Harku lake | The problem of Harku lake—can we solve it? |
| 9. How to avoid bicycle accidents | No change |

learning situation by being asked to try out the scripts used as exemplary material on day 2).

To put together the students guide, the teachers guide and let it follow the educational goals was a time consuming process. The first versions of the scripts did not give a full description covering these aspects. Also the participants had difficulties in including socially oriented goals and often these was omitted. These were usually more fully developed or added by the organizers after the workshop.

During the 4 days, 9 scripts were developed. As earlier planned, the criteria put forward during the workshop was used to modify scripts and the modified versions were sent back to the authors to seek their understanding the new philosophy and its need and at the same time enable teachers to leave with STL material. We are charged with satisfying the educational needs of children who will be the adults of tomorrow.

The scripts, developed by representatives from 9 countries, will be translated into the national language and tested by teachers during the current school year. The evaluations will be collected and used by the workshop organizers to improve the tested materials and to add STL assessment strategies.

Reference

Science Education Around the World

Member associations and individuals are invited to contribute to this section. Suitable items include brief accounts of specific projects of international significance, science education in a particular country, or international and regional seminars and conferences.

A NEED FOR UNITY IN DIVERSITY, II

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Introduction

It may have been evident that ‘A Need for Unity in Diversity, I’ spread into what might be called the ‘Greater Sciences’: Moral; Economic; Domestic; and others, besides having its roots firmly in the Natural Science of Human Biology.

In 1993, a precursor to the S.E.I. article of March 1994 was sent to fifteen of the National Academies of Science preparing for the World’s first Summit of National Academies of Science which was held in New Delhi in that year. In its preparatory stages, lasting some two years, the conference moved from a wide environmental forum to one on population and related issues. ‘Population, the complex Reality’ is the account of the New Delhi lectures.

This article develops points from S.E.I.’s Feature Article of 1994, presents material for direct photocopying for class use, and challenges you to send us notes to further education on population issues.

Graphs and Notes

Figure 1 is presented for direct photocopying for class use.

The latest figure available: that the world population reached 5.7 billion people in May of this year shows that the population explosion continues on its way.

Sir Francis Graham-Smith, editor of ‘Population—the Complex Reality,’ summarises the 400+ pages by calling for zero population growth in the lifetime of today’s young people. This is calling for a horizontal graph line; no upwards slope at all.

Figure 2 is also presented for photocopying for class use. While scientific progress must depend on past discoveries, it also depends on speculation. In this case public opinion and forethought to acknowledge the stupidity of overpopulation is paramount.

Jonathan Porritt has set up a small organization called ‘Passport to the Future’ which encourages groups of young people to make resolutions which they enter in their passports. On the television film ‘Sex, Sin and Survival,’ he says: ‘Best practice in family planning could become commonplace all but overnight, but it is just not happening fast enough. The real blockages can be traced back to the intolerance and complacency of millions and millions of people . . . the short-sighted . . .’

Social Effects of Over-population

The majority of these—the opinions given in our five year forum—should be reviewed in the March 1994 issue of S.E.I. A subject area that does not feature there is the multiple births problem created by recent advances in medical science.

For what might be called ‘the New Delhi Wish’ to come true, on average, each adult may produce but one child—the two child family.
Formulae

Philip Musk, a mathematics research worker at Oxford University, produced the formula below to account for the effect of one exponential on top of another.

\[ y = x^{kt} = (\log x)^{kt} = \log y = (n \log \log x) \]

Plots using this are, appropriately, like graphs of brick walls!

For those who prefer simpler mathematics, try

\[ S = f(P \times L) \]

where \( S \) = environmental stress
\( f = \) 'a function of'
\( P = \) the human population, and
\( L = \) an average standard of living.

- It leaves scope for discussion and diverse interpretations, thus being a starting point for logic radiating out in many directions.
- It may be applied for localities, towns, cities, counties, nations or to the world as a whole.
- Discussion is required in order to choose units so that the physical dimensions are the same on both sides of the equation. \( L \), for example might be G.N.P. or G.D.P., thus bringing money into an environmental equation!

Two formulae of this kind come in Paul Harrison's book, 'The 3rd Revolution'. He quotes Paul Erlich's

**impact** = **population x affluence x technology**.

This, like \( S = f(P \times L) \), stimulates discussion and also needs units.

His own formula is

**environmental impact** = **population x consumption per person x impact per unit of consumption**.

Although quantification is part of the scientific method, over-much of it may defeat the overall aim. In the last resort, as now, common sense is what really matters!

Challenge to You

If you would like to join an educational drive on population education and related issues.

- please send us the ideas you think the most important;
- indicate whether you would be interested in a population forum at the December '97/January '98 General Assembly/ASE meeting in Liverpool, England.

Don't delay. What can be organized in the time depends on early feedback.

References and Addresses


5. Population Concern. 178-202 Great Portland Street, London W1N 5TB.

1. There are now more people alive in the world today than have ever lived in total before. (a) Is this idea new to you? (b) Do you believe it?

2. There are more than 5,000,000,000 people alive today, and the population explosion curve shown on this page shows no sign of levelling off:
   (a) Do you see this as a serious matter?
   (b) Should nature be allowed to take its course, or should measures be taken to help the curve towards a steady level? (Underline the option you support)
   (c) List the main consequences you think go with overcrowding.
   (d) What population control measures do you think are acceptable?
   (e) What population control measures do you think are not acceptable?

3. (a) Do you agree that the greater the number of people, the less the room for wildlife? (b) Does this concern you?

4. (a) Would you like to have children of your own in time? Or (b) how many children do you already have?

5. How many children would you like to have?

6. In view of world overcrowding, how many children do you think you should have?

7. Assuming that it is desirable for all people to have a fair quality of life, and that this does not go with overpollution and exhaustion of resources, what do you consider to be the optimum level for the world's human population?

8. (a) With respect to the possibilities which curve do you think is the most likely to happen? Number......
   (b) Which curve would you prefer to happen? Number......
   (or draw your own versions on the reverse of your answer page, stating which is 8a and which is 8b.)

9. Please state your:
   (a) age
   (b) sex
   (c) locality (town, county or state, country)
   (d) country of birth
Populations sometimes alter sharply as shown above. If the Academies of Science 'New Delhi Wish' is to happen peacefully, worldwide forethought is vital like never before! Fossil fuels will run out in time; environmental damage and destruction will continue; shortages will increase. Your resolutions now will help to make the kind of future you want for yourselves, and for your children in the course of time.

Choices 1-4 below involve catastrophe; No.9 is far too risky; 5-8 possible and reasonable.

I prefer No. .... and suggest these ways of achieving it:

...........................
...........................
...........................
...........................
NETWORK FOR SCIENCE TEACHING
IN THE STATE OF RIO DE JANEIRO, BRAZIL

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Introduction

The "Rede Regional Fluminense (RRF)" is a network for Science Teaching based at the Universidade Federal Fluminense (UFF), Niterói, State of Rio de Janeiro and brings together researchers, university lecturers, science teachers and pupils. Its main project is a science teaching center called "Espaço UFF de Ciências" which aim is to promote science and mathematics for schools and general public.

The "Espaço UFF de Ciências" is a sum of several activities which have been developed in the last ten years. The activities started with a project targeted to science teachers in primary schools called "Active Science at Schools." The main feature of the project is the practical aspect of the proposal presented to science teachers. Through the project was possible for teachers and university lectures to discuss about the use of the recent results of research in science education in the classroom. The project adopted an interdisciplinary approach and had made use of experimental activities and created suitable instructional materials to be used by the science teachers.

The work done by the RRF initial group allowed the interaction with some disciplinary groups of the university who were also interested in reflecting upon general problems happening in schools and specific ones concerned to the learning of science and math. The current group in charge of the project is composed of lectures of the Department of Biology, Physics, Chemistry, Mathematics, Earth Sciences, Psychology and the School of Education who intend to develop a methodological proposal for active learning in science. Alternative conceptions as a research approach have been mostly used by the RRF group who recognizes the importance of the pupil's background knowledge to learn new concepts. Conceptual change, as well as interdisciplinary approach for science teaching is an area of interest of our group.

The increase of the number of members in the group and changes in the kind of support offered to science teachers have lead to an expansion of the physical space and a diversity in the activities. Also, an increase in requests from many teachers, schools and even from the Educational Authority of the State of Rio de Janeiro, allowed the existence of many projects. These activities are, for example: video exhibitions, workshops, regional meetings for science teachers, courses in History of Science and Technology, exhibitions in national meetings, etc.

Therefore, the RRF main goal is to carry out these activities aiming to promote science in the State of Rio de Janeiro in such a way that it may contribute to improve the quality of science teaching at schools. Thus, the network goals include:

- divulgence of the results of research about how pupils learn and other related themes linked to science education;
- promotion of group discussion about themes such as: pupil as the one responsible for his/her own knowledge; the role of school and the contribution of science and math teaching towards the formation of the citizenship; transference of the research results into classroom contexts; etc.
- production and divulgence of technical and scientific materials;
- creation of new Science Centers or Science Clubs at the University and at schools;
- improvement of cultural, technical and scientific knowledge of pupils, teachers and general public.

Theoretical Background

As mentioned earlier, the group's research background is related to pupil's intuitive or alternative
conceptions. Children, pupils and adults build up patterns and explanation about the world that surrounding them, since they were born. However, in many cases, their conclusions do not get close to those presented by science.

Researches have shown that the way of approaching scientific knowledge is basically the same for children and scientists. However, "science of children" is quite different from "science of scientists" (Driver, Guesne & Tiberghien, 1985). These differences are due to many factors such as:

- children's self-centered view of the world
- children's curiosity leading to particular explanations related to isolated events without making generalization;
- a scientist's hypothetical reasoning which children do not have;
- distinct languages: words being used with different meanings by scientists and nonscientists;
- some of scientists' conceptions for which there is no example based on direct observation.

Children's explanation make sense for them. Not rarely, they even make more sense than those given by science and presented by teachers ('science of teachers'). In spite of that, it was through abstract thoughts, generalization, decentralized view, appropriate speech and abstract patterns that science developed the power to know and to explain nature in the way we have in our days.

Pupils build up a logical system associated to a group of patterns which allow them to interpret the world. They do that during the period they attend school and even before that, in spite of the influence of school and the influence of the teaching system as a whole. This situation creates a great persistence of what is called 'science of children' which, in many cases, can be found both in primary teachers and graduate students (Viennot, 1979).

These patterns mentioned above have been interpreted, several times, as "pupil's mistakes." However, researches have demonstrated the existence of regularity in these 'mistakes' as well as many analogy with patterns of ancient times of history of science (Villani, Pacca, & Hossoume, 1985).

Also, researchers in physics teaching, followed by researchers of other professional and cultural fields, have studied pupils' alternative or spontaneous system. This not only expanded this area of studies but also directed it to investigation concerning to mental models and its importance in science teaching (Gilbert, 1993).

General Methodology

Basically, the RRF network works through activities which include: research; teaching; scientific events with articulated actions to allow the interchange of knowledge among participants; production of school materials to be tested inside classroom.

All these activities are present at the projects developed as part of the work of the network, which will be described in the following section.

The Network Projects

The network develops several projects, many of them partially supported by the Educational Authority of the State of Rio de Janeiro. In many cities of the state, there are actions which receive some kind of support from the local authorities which, basically, consists of enabling teachers to attend meetings, workshops or in-service training.

Among the projects developed by RRF, the following ones are outlined:

- **Active Science at Schools** (developed with primary science teachers and student-teachers of the School of Education);

- **Physics Teaching Programme** (developed at High Schools and Physics Laboratories at University);

- **Historic-cognitive Analysis and Science Teaching Group**;

- **Science Classroom Project** (study of topics in Biology and production of school materials to be tested in classrooms);

- **Geometry Experimental Laboratory** (application of a specific methodology to geometry basic subjects);

- **Science and Leisure Programme** (interdisciplinary events for general public);
• ‘Science at Square’ (events and classroom activities promoting science to school and general public);

• Science Teaching at Junior High School: Chemistry and Physics topics1 (a project which the research group includes science teachers as well as university researchers);

• “One swallow does not make a summer” (a project that goes to schools and involves science teaching at age 6 up to 14 in three regions of the state of the Rio de Janeiro);

• Science Teaching and Racial Issues.

Some exhibitions have been held at the Annual Meeting of the Brazilian Society for the Advance of Science (SBPC) in places outside Rio de Janeiro: Galileu Galilei (held at Recife State of Pernambuco, 1993); Science and Colours (held at Vitoria, State of Espírito Santo, 1994); Science and Art: Colour, Light and Movement (held at São Luís, State of Maranhão, 1995). An exhibition named Chaos and Fractals was held at the Espaço UFF de Ciências, Niterói in 1994.

The RRF is also linked to the Red de Popularizacion y Divulgacion de la Ciencia (RED POP), a network for science teaching in Latin countries. Every two years a meeting is held in order to establish interactions among the members. The RRF has just started an interaction with Colombia, mainly with the work developed by Julian Betancourt (for a better description of the work, see Betancourt & Cordoba, 1986).

Conclusion

As said previously, the network activities promote a significant interaction among teachers, pupils and researchers who work with science teaching all over the State of Rio de Janeiro. In order to achieve this aim, the network has established a number of interchanges with other universities, research groups, science centers (like the Science Teaching Center of the State of Rio de Janeiro, CECIERJ), science museums (like the Museum of Astronomy and Related Sciences, MAST and the Living Science Museum, “Ciência Viva,” both in Rio de Janeiro city) and others.

By participating at RED POP it is possible to pursue an expansion of the network even to an international extent. It is important to stress that by doing so, the network goes as far as other countries of Latin America which share common needs and common goals that are familiar to us. That is the time to establish cultural relationship with other countries, mainly with those which are respected for their experience both in science teaching and museology.

We hope that other interchanges that may exist in the future represent an effort to promote science for the improvement of the quality of science teaching and the society, as a result.

Bibliography


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1 The school year in which pupils are introduced to these subjects.
CONASTA 46
Annual Meeting of the Australian Science Teachers Association
June 29-July 4, 1997
University of Melbourne

The Theme
Science Down Under—Extending the Boundaries’ Our aim is to provide science teachers with up-to-date cutting edge information on the thinking of Australian scientists and near neighbours. The programme will also highlight practice and theory suitable for all levels of science education. It is our intention to extend the boundaries of knowledge.

Exhibitions
Throughout CONASTA 46 there will be extensive displays and showcases of science resources, videos, computer software, laboratory apparatus and curriculum materials.

Excursions
A full range of social and informative excursions are being planned to enhance the program. A special Sunday welcome function is being organised, along with a Conference Dinner featuring a mystery tour. A post-conference excursion programme will be available.

Registration
The registration brochure will be available later this year and will be sent to all members of the Australian Science Teachers’ Association. Initial expressions of interest can be filled in on the back of this brochure.

Travel
Qantas has been appointed the official airline for the conference and will be offering discounted conference airfares for conference delegates and accompanying persons. Full details will be included in the registration brochure.

The hard copy of your abstract should be submitted by November 1, 1996. Further information will be required by the STAV Secretariat as soon as practical after this date.

Presenters will be notified of their acceptance of Workshops/Seminars and all presenters are required to register for the Conference.

For more information contact:

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Introduction

Studies assessing students’ images of scientists (Krause 1977; Chambers 1983; Schibeci & Sorenson 1983; Fort & Varney 1989; Huber & Burton 1995; Finson, Beaver, & Cramond, 1995) have shown that students possess interesting stereotypic images of scientists. For example, students generally perceive scientists as being white males who work alone in a laboratory. Chambers (1983) and Schibeci and Sorenson (1983) found that as young children progress through successively higher grade levels, their images of scientists become more and more stereotypic until they reach fifth grade. At this time, their stereotypic image of a scientist appears to be fully developed.

The most common technique used to assess students’ images of scientists has been the Draw-A-Scientist Test (DAST) developed by Chambers (1983). In using DAST, investigators ask students to reveal their image of a scientist through a drawing. To provide a reliable and efficient format for analyzing students’ drawings, Finson, Beaver, and Cramond (1995) developed the Draw-A-Scientist Checklist (DAST-C). Each item on the DAST-C represents a stereotypic characteristic derived from reviews of literature relating to students’ images of scientists. During the analysis of a student’s drawing, the more items “checked” on the DAST-C, the more stereotypes appear on the student’s drawing. Although the DAST and the DAST-C are useful tools in gaining insight into students’ concepts of scientists, Finson, Beaver, and Cramond (1995) identify two cautions in the use of these instruments:

“Maoldomhnaigh and Hunt (1989) reported that students may possess more than one definition of the word scientist, and this may result in students drawing different images at different times without having their perceptions changed by a particular treatment. Additionally, Maoldomhnaigh and Mhaolain (1990) found that changing the wording in directions given to students can alter the types of drawings produced. Such results underscore the importance of having a standardized procedure, including standardized instructions, to follow when administering the DAST. In addition, although the DAST-C appears to yield results similar to those obtained through structured interviews (indicating it accurately assesses students perceptions of scientists), it may fail to elicit all the richness of data possible through interviews (p. 204).”

The Portrayal of Scientists in the K-12 Curricula

Since the early 1970’s, concerted efforts have taken place to present inclusive images of scientists and to show how they engage in the scientific enterprise. For example, in K-12 science programs, women and ethnic minority groups are depicted as having active roles in science. In features like “Ask a Scientist” in Addison-Wesley Science, scientists are portrayed as “regular people” who dress in everyday clothes and are able to communicate about their scientific activities to children (Barman et al., 1992). Science related careers are highlighted in Destinations in Science (Brummett et al., 1995), Discover the Wonder (Heil et al., 1993), and MacMillan/McGraw-Hill Science (Atwater et al., 1993)
to show students that “doing science” occurs in a variety of occupations. In addition, some science programs have incorporated features that show students how science occurs in their everyday lives. For example, the “Back Home” feature in Destinations in Science (Brummett, et al., 1995) invites students to use their home or neighborhood to study science and the “Technology and Society” feature in Macmillan/ McGraw-Hill Science (Atwater et al., 1993) shows students how science knowledge and the application of science relate to the everyday life of themselves and their family members.

The way students studied science has also been an area of concern for science educators and curriculum developers. The main issue has been to find ways for students to be “doing” science rather than just reading about it (Kahle, 1992). Therefore, most recent K-12 science materials have included a variety of activities that encouraged students to engage in the same processes that scientists use. In these activities, students describe objects and events, ask questions, construct explanations of natural phenomena, test those explanations, and communicate their ideas to others.

**Procedures**

Because of the concerted efforts since the 1970’s to provide students with a realistic image of scientists and how they go about “doing science,” we are interested in addressing three specific questions related to the way students view science. Specifically, we will focus on the following questions: (1) What are the current images that students have of scientists? (2) How do students perceive they study science in school? and (3) Do students perceive they are using science outside of school? To address these questions, we devised a protocol that incorporated the current methods of DAST, some techniques to take into account the cautions suggested by Finson, Beaver, and Cramond (1995) which relate to using a standardized procedure and structured interview questions, and procedures that we felt would further enhance our ability to understand the students’ perceptions of scientists and science.

An initial concern that we had about DAST was related to asking students to make a “forced choice.” If you ask students to draw a scientist, does this force them to make a choice between a male or a female? Or, if you ask students to draw two scientists, would this provide them with the freedom to depict both sexes? To answer this question, we randomly selected two groups of ten fifth grade students. Each group had an equal number of boys and girls. Group A was asked to draw two scientists doing science while group B was asked to draw one scientist doing science. In group A, 7 students drew two male scientists, 2 students drew a male and a female scientist, and 1 student drew 2 female scientists. In group B, 7 students drew a male scientist and 3 students drew a female scientist. Because the drawing of two scientists took each student twice as long to complete as the drawing of one scientist and because there appeared to be no major differences in the results of groups A and B, we decided to develop our protocol with students drawing only one scientist.

We also wanted to provide students with an opportunity to draw scientists from different racial backgrounds. Therefore, we provided each student with a set of colored pencils or crayons before they were asked to draw a scientist.

Each student was given the following directions and asked questions individually. Even though each student was asked a set of standard questions, each interview session was informal enough to allow the investigator to gain additional information about the students’ drawings and to clarify any of their responses. The responses were audio-taped and later transcribed for further analysis. The set of directions and questions used in each interview session are:

- Will you please draw a picture of a scientist doing science? When you are finished, will you please explain your drawing?

- On another piece of paper, will you please draw a picture of yourself doing science in school? When you are finished, will you please explain your drawing?

- Can you think of some ways you use what you learn in science outside of school?

**Sample**

One hundred and seventeen fifth grade students (57 males and 60 females) from the midwestern and southwestern parts of the United States were chosen for this study. Eighty seven of these students came from one private school and two public schools in a large midwestern city. The remaining 30 students came from a private school in a large southwestern city. The students enrolled in the private school in the midwest were primarily from middle to upper income families while the students from the private school in the southwest were mostly from middle income families. The two public schools from the midwest contained students primarily from low to middle income families. In terms of ethnic background, 73 students were
Caucasian, 40 students were Afro-American, and 4 students were of Asian descent.

Analysis Procedures

The student's drawings of scientists were analyzed using the DAST-C. Each drawing was rated for specific stereotypic images and additional information obtained from the student interviews was compiled and reviewed (Table 1).

The drawings of students doing science were grouped into two main categories: (1) those who pictured themselves as passive learners such as reading about science or taking notes at a desk and (2) those who saw themselves as active learners (Table 2). Additional information obtained from interviews was also compiled and analyzed.

Data related to students' perceptions about using science outside of school were gathered from the interview transcripts. These data were categorized into four main groups: (1) students who think they can use science but are unsure how, (2) students who only see themselves using science by repeating activities from school, (3) students who could generalize the use of science knowledge and processes to everyday situations, and (4) students who did not see any use of science outside of school (Table 3).

Results

Perceptions of Scientists

As shown in Table 1, the students in this study had similar images of scientists to those revealed in previous studies (Chambers 1983; Fort & Varney 1989; Finson, Beaver, & Crammond 1995; Huber & Burton 1995). Generally, the students perceived scientists as being white males who do their work in some type of laboratory.

A few other items worth noting about the students' drawings of scientists are related to the scientists' clothing and their facial expressions. Scientists wearing regular clothing such as bluejeans and t-shirts are depicted by 20% of the students while 26% pictured the scientist in a lab coat. In regard to showing any facial expressions on the scientists, most of the students depicted scientists with no expression. However, 23% of the students did draw scientists with smiles on their faces. When asked to explain this aspect of the drawing, the students generally indicated that the scientists enjoyed their work.

Perceptions of School Science

When the students were asked to draw a picture of themselves doing science in school, 56% drew themselves at desks either reading a science book or taking notes. When asked about their drawings, several of the students said that they usually sit at a desk and read their science book. However, these students also indicated that they would prefer to do some type of activity during science. Doing some type of science activity was depicted by 27% of the students while 17% drew themselves outdoors looking for insects, leaves, rocks, or plants.

Perceptions About Using Science Outside of School

The majority of the students (60%) viewed the use of science outside of school as an extension of their school experiences. Students cited specific school activities that they did at home such as mixing vinegar with baking soda. Several students stated that they were able to help one of their younger siblings with their science homework because they had been given similar assignments. It was felt by 26% of the students that they never use science outside of school and 5% thought they probably use their science knowledge and skills outside of school, but they were unsure as to how they use the knowledge or skills.
A total of 9% of the students were able to connect the skills and knowledge they gained from science to everyday activities. For example, these students cited how they use problem solving, making observations and inferences, identifying small animals and plants, predicting weather, and caring for plants and pets in their everyday lives.

**Figure 2**

**Typical Student Drawing of How Science is Studied in School**

![Image of a student drawing]

**Discussion**

Although steps have been taken by curriculum developers and science educators in the last few decades to highlight women and minorities in science, most of the students in our sample perceive scientists as white males who practice science in some type of laboratory. This points to a continued need to search for ways to show K-12 students that scientists are represented by both genders and are from a variety of ethnic backgrounds. In addition, scientists should be portrayed as everyday people. Therefore, teachers need to be encouraged to use the special features in science textbooks that highlight science careers, depict scientists as everyday people who are capable of sharing their work with non-scientists. Resources, like *Dragonfly* (Project Dragonfly 1996), could also help teachers present students with an inclusive image of science and scientists. *Dragonfly* is a publication in which students interview scientists and publish the procedures and results of studies they have conducted. In addition, this magazine highlights the work and daily lives of scientists.

The most recent K-12 science curriculum programs include activities to engage students in "doing science." However, a large number of students in our sample perceive their school science experience as either a reading exercise or a time to listen to someone lecture about science. The National Science Education Standards (National Research Council 1996) has explicit recommendations about teaching science as a process of inquiry. Teachers need professional development which provides dialogue and concrete examples designed to help them put these recommendations into classroom practice.

Videotapes featuring scientific expeditions and investigations would present scientists in a dynamic mode. Inviting women and minorities to talk with the class about how they learn about and use science would offer opportunities for students to broaden their ideas about scientists on a more personal level. Building on these experiences, pointing out the scientific contributions by females and minorities would continue to broaden student perspectives. The historical sequence in the development of our understandings about the way things work would help students gain an appreciation for the personalities of scientists as "real people."

Our findings in this study indicate that most students do not see a connection between what they learn in science and how it can be applied to their everyday lives. Students need to be presented with concrete examples that demonstrate the connection between school science and what they do outside of school. For example, teachers could engage students in activities that show them how specific skills like observing, measuring, and classifying are used in everyday activities (Mercier & Ostålund, 1996). Students could be encouraged to make collections of things such as rocks, leaves, insects, etc. in order to discover patterns and to develop classification skills.

Engaging students in product testing is an effective strategy for learning how to use the skills of science. As students conduct a "fair test" for various products they will learn how to control variables in an investigation. This may help make science more relevant for students. Additionally, involving teams of students in long term investigations will help them get a feel for the work that scientists do. These projects simulate what scientists do, e.g., working together to formulate a question, making observations, gathering data, drawing conclusions, sharing and challenging conclusions drawn from data, and finally trying to reach
consensus. Additionally, making connections with math and communications creates a realistic view of doing science.

Science classes could also incorporate live communication with scientists. For example, Internet connections can involve classes around the world in conducting research and sharing data on phenomena such as the pH of rain. The Jason Project is another way students can engage in doing science with active scientists.

Final Note

The next step is to plan and implement a pilot program using some of the ideas presented above. Since assessment often drives the curriculum, if students’ ideas about scientists and how they use science everyday is evaluated, teachers will be more likely to employ strategies to increase realistic perceptions. The information that we obtained in this study has been limited to a few schools in the midwest and southwest. We encourage others to use the protocol discussed in this paper to gain insights about how students in different parts of the United States perceive science and its relevancy to them. We also believe that the protocol discussed in this paper should be used on a continual basis by teachers to collect information about how their students’ views about science change over time. These data would provide valuable feedback to teachers regarding whether their students are developing a realistic perception about science and its usefulness to them. This information could serve as an evaluation tool for teachers to assess the effectiveness of their science instruction.

References


Table 1

Students' Stereotypic Images of a Scientist

Total N = 117

<table>
<thead>
<tr>
<th>Common Stereotype</th>
<th>Students responding (in %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Scientist Wearing a Lab Coat</td>
<td>26</td>
</tr>
<tr>
<td>2. Scientist Wearing Eyeglasses</td>
<td>26</td>
</tr>
<tr>
<td>3. Scientist With Facial Hair</td>
<td>5</td>
</tr>
<tr>
<td>4. Symbols of Research Displayed (e.g., instruments, lab equipment, etc.)</td>
<td>85</td>
</tr>
<tr>
<td>5. Symbols of Knowledge (e.g., books, clipboards, pens in pockets, etc.)</td>
<td>15</td>
</tr>
<tr>
<td>6. Technology Represented (e.g., telephone, TV, computers, etc.)</td>
<td>11</td>
</tr>
<tr>
<td>7. Relevant Captions (e.g., formulae, classification, “eureka,” etc.)</td>
<td>7</td>
</tr>
<tr>
<td>8. Male Gender Only</td>
<td>80</td>
</tr>
<tr>
<td>9. Caucasian(s) Only</td>
<td>93</td>
</tr>
<tr>
<td>10. Scientist is Middle Aged/Elderly</td>
<td>10</td>
</tr>
<tr>
<td>11. Scientist has Mythic Stereotypes (Frankenstein creatures, etc.)</td>
<td>15</td>
</tr>
<tr>
<td>12. Indications of Secrecy (Warnings of “private,” etc.)</td>
<td>2</td>
</tr>
<tr>
<td>13. Scientist is Working in Lab</td>
<td>90</td>
</tr>
<tr>
<td>14. Indications of Danger</td>
<td>11</td>
</tr>
<tr>
<td>15. Open Comments Related to dress items, neckties, hair style, smile/frown, etc.</td>
<td></td>
</tr>
<tr>
<td>- 20% depicted scientists wearing regular clothing (e.g., bluejeans, T-shirt)</td>
<td></td>
</tr>
<tr>
<td>- 23% drew the scientist with a smile</td>
<td></td>
</tr>
</tbody>
</table>

Table 2

Students' Perceptions of "Doing Science" in School

Total N = 117

<table>
<thead>
<tr>
<th>Activity Represented</th>
<th>Students responding (in %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Seated at Desk Reading or Taking Notes</td>
<td>56</td>
</tr>
<tr>
<td>2. Participating in Activity</td>
<td>27</td>
</tr>
<tr>
<td>3. Other (looking for insects, leaves, plants, or rocks outdoors)</td>
<td>17</td>
</tr>
</tbody>
</table>

Table 3

Student Perceptions of Using Science

Total N = 117

<table>
<thead>
<tr>
<th>Category</th>
<th>Students responding (in %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Never Use Science Outside of School</td>
<td>26</td>
</tr>
<tr>
<td>2. Activities are Extension of School Assignments</td>
<td>60</td>
</tr>
<tr>
<td>3. Did Use Science But Not Sure How</td>
<td>5</td>
</tr>
<tr>
<td>4. Could Generalize Use of Skills and Knowledge of Science to Everyday Situations (e.g., solving problems, making observations and inferences, animal and plant identification, predicting weather, and care for plants and pets)</td>
<td>9</td>
</tr>
</tbody>
</table>
THE HARARE GENERATOR: CURRICULUM DEVELOPMENT AT HIGH SPEED

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Introduction

The Harare Generator was a meeting of African educators at which participants first exchanged ideas on innovative approaches in science education, generated resources, tried them out in schools and then discussed how they might be refined. The results included draft written guide materials, videos and slides, relevant to their own work all in 2 weeks. These were subsequently edited in Africa by a small group of African educators drawn from the Generator.

The aims of the Harare Generator included the following:

- encouragement in the use and adaptation of the product.

It was seen that the product of the Harare Generator could be the means by which some new ideas and directions might be injected into the teaching and learning of science in Africa, particularly through teacher education programmes.

The Generator philosophy

A generator is an energy conversion device which requires some significant input in order to be of any use. The underlying philosophy of the Harare Generator was a hands-on approach. Many science educators feel that effective science learning typically involves some problem-solving activity. If this problem relates to some major area of human need it may also be linked to applications of technology in such fields as agriculture, environment, health or industry. In this way, science may become more relevant and meaningful to the learner, and applicable to the society in which he or she lives. The Harare Generator attempted to improve the efficiency of the teaching and learning of science in African schools by means of a shift towards a more problem-centred approach. This was done by focusing

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‡ Curriculum and Teaching Studies
on (i) information transfer, (ii) visual media, (iii) creativity development, (iv) low cost teaching resources, (v) science, technology and social issues.

The Generator

The participants were drawn from a wide spectrum, by a system of recommendations nominating those who were actively engaged in science education in Africa, and who would have the opportunity to continue to use, adapt and generate ideas after the event. These were mostly lecturers, teachers, curriculum developers and education officers, drawn from fifteen African countries which responded to the invitation, with a few others from outside Africa. Further, primary and secondary teachers from Harare and nearby participated and also helped participants to try out their ideas in their schools.

The organising committee was drawn from the Faculties of Education and Science at the University of Zimbabwe, the Zimbabwe Ministries of Education and the local science teachers’ association with the guiding hand of Mike Robson, of the University who was also on the Committee on Teaching of Science of the International Council of Scientific Unions (ICSU CTS) the lead international agency for the meeting. The organising committee was responsible for inviting the resource persons and participants, soliciting ideas for the programme and making all the necessary local arrangements.

The actual meeting developed in four stages: inputs, generation, performance and product. It began with inputs which included presentations illustrating new ideas in audio-visual techniques, design and technology in schools, developments in primary science, generating useful materials, popular science publishing, preparing project proposals, production of low-cost science equipment, science education and future human needs, science education beyond the classroom, and science, technology and society.

The second phase of the Generator involved the generation of ideas, plans and practical programmes based on the earlier inputs. Participants chose two (out of 18) areas of focus to develop ideas and materials for trialling. During the second week these ideas were then tried out in schools and evaluated and redrafted with teacher guide notes in the third phase. The materials developed were collected together in a package from which a report and proposals for future activities were produced by each of the working groups, the first part of phase 4. On the final morning of the conference, each working group made a poster and verbal presentation describing the work they had done.

Each phase of the Generator was recorded by photo and video and the ‘rough’ versions were ready early enough to show to the participants on the last day.

The last part of phase 4 was entrusted to four participants, led by Patrick Whittle, who edited the resources which have been published by ICSU CTS (1).

The Generator products

(i) Intangible outcomes

Individual participants had the opportunity to listen to the accounts of innovations in their own and in other countries and to participate in the brainstorming, planning, adapting, modifying and testing of new ideas under the pressure of tight deadlines and limited resources. While they are all frequently called upon to do these things at home, and are used to severe constraints of time and finance, few of us are able to enjoy the opportunity of collaborating with so many other like-minded specialists with such a varied and wealth of experience. We have several examples already how contracts, established across international borders during the Generator, have prospered.

(ii) Project proposals

After reflecting on their endeavours, each group made lists of suggested projects related to their area of study, which might be attempted in their own countries, with detailed plans and costing, and several have already been submitted to funding agencies and are now being implemented. It is hoped that the Generator itself will be replicated in other countries.

(iii) Written materials

Each of the eighteen working groups of the Generator kept a detailed written record of their initial discussions, their plans and how they were developed. They also described field trials with children in the schools, reported the evaluation of those trials and suggested various follow-up project proposals. These written resources formed the basis of a book which has been substantially edited to give coherence (1).

The eighteen products of the working groups have been clustered into five chapters on related areas concerned with (i) pupils’ activities, (ii) pupils’ thinking, (iii) school science facilities, (iv) environmental resources, and (v) more sophisticated teaching/learning aids. The reports, written with teacher educators in mind, have been presented in a form which can readily
be used by science educators in Africa, and in other developing and developed areas.

(iv) Slides and videotapes

Two sets of sixty slides each are available. Set A illustrates the nature of the Harare Generator concept, process and product. Set B shows the five clusters of activities carried out by the working groups, with the major focus on the trials of these activities with children in local Zimbabwean schools. These two sets can thus be used to examine the Generator concept, or to explore the innovations in science education themselves.

There is also a three-hour VHS/PAL videotape containing: (i) a preview of the Harare Generator and its 18 group activities; (ii) Unit 1, the games group’s preparation, trial and evaluation in some detail and (iii) extracts of the main activities of the remaining Units 2 to 18. These can be obtained at the same time as the book (1).

Using the Materials

(i) Generating generators

The Harare Generator report and the accompanying resource materials can be used in many ways. One suggestion is to use the Generator as a model from which to replicate the event for groups of teachers and science educators at a local, national or regional level. The actual purpose may be different but the same approach can be adapted. The manual gives suggestions about the way to set about it. The starting point would be the book, together with Slide Set A, or Section A of the videotape. Ideally one of the original organisers or participants would provide some first-hand advice, but this is not essential, provided a core of science educators exists to form a planning committee, under the aegis of an association, institution or ministry, in that country.

(ii) Pre-service science education

Each of the eighteen projects carried out at the Harare Generator is a worthwhile topic for study by student science teachers. These projects can be replicated within a teacher training college or university education department, as some already have. The relevant chapter of the book provides the necessary background information, together with a list of references. References to further reading are also provided.

Suggested approaches for individual units for teacher education are included at the end of each chapter in the book. The essential element is to expose the student teachers themselves to an activity which will provide some personal experience of the particular “innovation” being considered. This may involve discussion or analysis of some visual material, a simulation or role-play activity, or a mini-project. Some possible objectives for these teacher education activities have been included in the teacher education notes.

(iii) In-service education

Practising science teachers bring their own experiences and felt needs to an in-service programme. Again, suggested approaches are made for the format of meetings using resources from the Generator. The check-list adopted by the INSTANT in-service project in Namibia has much to commend it, advocating a teacher-centred, teacher-driven approach with a strong classroom focus. One suggestion is to show the preview videotape of the Generator, or the set of slides of the conference, and then ask participants which of these methods they have tried. Some members could then describe their own experiences as an introduction to a particular unit.

(iv) Non-formal science education

The Harare Generator slides and videotapes are a useful resource for audiences who are not necessarily specialists or students of science education. They may be used at seminars, conventions, conferences, or open-days, when educationists, students, parents or the general public are being informed about current trends in science teaching.

(v) Cross-curricular activities

Many of the community and real-life centred approaches which were advocated by the Generator impinge upon other science-related subjects such as agriculture, environmental studies, geography, health education, home economics, mathematics or technical studies. Consequently these activities provide a good opportunity for cross-curricular work by a team of different subject specialists. Science education does not have a monopoly of all the best ideas and methods. Some of these ‘new’ science teaching techniques have been used for many years by teachers of the humanities, so it may be profitable to engage in activities with them particularly when social or ethical issues are being discussed.

Since the Harare Generator resource materials include many examples of general educational principles, in an African context, lecturers in educational...
foundation areas may also find them of use. English language education specialists will also find they can make use of them. They may also be used in a general teaching methods course, where the slides and/or videotape will provide non-science specialists with sufficient background information to be able to discuss the technique.

While these suggestions are intended to aid design of appropriate learning experiences for teachers based on the units, experienced teachers could also use the Harare Generator examples as a springboard for developing other innovative techniques or experiments in their science teaching. Cross-curricular work where different specialist teachers combine efforts to plan some learning experiences for their pupils which cut across the normal strands of school subjects is worthwhile because it is closer to real life than the normal subject lesson. Integrated projects or studies are valuable because they involve the problems and pleasures of daily living. Several of the innovations described lend themselves to such cross-curricular activities both between pure and applied science subjects (2) or between sciences and more sociological school subjects.

Postscript

But, let us finish with the words from a recent review. "The book is a gold-mine of ideas which have direct classroom application; they will be especially useful as stimulus material in pre- and in-service education" (3). It is hoped that the resources can be distributed widely and for in-service programmes to be presented using them. If so, the organisers of the Harare will feel that their work is not in vain and the generous assistance from the International Council of Scientific Unions, the Rockefeller Foundation, the British Council, the Commonwealth Foundation and Unesco will be repaid.

Acknowledgements

Besides the funding agencies whose generosity has been acknowledged above we thank Mike Robson of the University of Zimbabwe whose original idea it was to mount the Generator, who directed it and without whose zeal and faith, it would not have occurred.

References


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Note to Member Organizations

Please ask your members to submit material to Science Education International. We are looking for:

- Teaching activities and lessons, especially for elementary
- Action research articles which talk to the practicing teacher
- Research articles which focus on practice, not research strategies
- Informal and nonformal articles which address "Things to do" in these settings

PLEASE INCLUDE PICTURES AND OTHER DRAWINGS OR GRAPHS.

Manuscripts may be sent to:

Ronald J. Bonnstetter, Editor
ICASE Journal
University of Nebraska
211 Henzlik Hall
Lincoln, NE 68588-0355
USA
SATIS 8-14—AN STS RESOURCE FOR YOUNGER PUPILS

John Stringer
Project Director, SATIS 8-14

How well does science in society (STS) material travel? The answer would seem to be ‘very well’—certainly judging by the success of the SATIS (Science and Technology in Society) projects of the United Kingdom’s Association for Science Education. SATIS materials for older students—14-16 year olds and 16-19 year-olds—have been widely translated and used in countries across the world. Building on that success, the Association first published a SATIS Atlas, and then wholly new projects for secondary school students—Science across Europe, Science with Technology and Science across the World. More recently, SATIS materials have addressed the younger age ranges—first children from 8-14, now 6-8, and soon, 3-6 years old.

SATIS materials place science and technology in context—sometimes a United Kingdom context, but more often one that any pupil might identify with. They are written by teachers for teachers; and their accuracy is authenticated by experts in the field—professional scientists, technologists, doctors, engineers, agriculturists. The materials are designed to enhance the prescribed curriculum, and, as a science programme might, SATIS presents an exciting and eclectic range of topics—see later for examples—that offer opportunities for teaching science concepts and practising science skills. All the units have curriculum connections—taking an unusual, sometimes unique, slant to familiar subject areas.

SATIS materials can be photocopied—but more often than not they are used to inspire and inform teachers; and to interest and engage pupils of all ages. Additionally, SATIS materials are industry sponsored, and so they are sold without profit.

The SATIS Atlas is a book of outline maps, easily copied or made into slides or overhead projection sheets. Every map is concerned with science and technology. While some of the maps are—understandably—about the United Kingdom, others tackle whole world issues, including energy and environmental questions. Overlaying one map on another is enlightening: putting the map that shows the parts of the world where clean water is limited on top of the map that records average life expectancy for each area produces a close and disturbing correlation.

Additionally, the Science across Europe initiative of the Association, in collaboration with British Petroleum, has produced seven units of work so far in ten European languages—English, French, Danish, German, Spanish, Catalanian, Italian, Dutch, Portuguese and Swedish. Each book contains maps, data, and teachers’ notes, together with copyright waived pages. Titles to date include ‘Using energy at home,’ ‘Domestic waste’ and ‘Global warming.’ More units are in development, together with fresh initiatives in other parts of the globe.

Science with Technology presents 18 photocopiable books covering the areas of Sense and Control, Anthropometrics, Food and Textile Technology and Green Issues, as well as appropriate Core Skills for the 14-19 age range.

Details of both these resources are available from

The Association for Science Education
College Lane
Hatfield
Herts
AL10 9AA
United Kingdom

SATIS 8-14

The material for 8-14 year-olds has potential for wider use. SATIS 8-14 has over 150 units of pupil material; like all the other SATIS projects, it is teacher-written, expert-endorsed, and low cost. Its range is exciting and stimulating; and while some of the topics are specific to Britain, others reflect the general interests of young people in any country—and the common view of the primary school curriculum.

SATIS 8-14 has Health Education units, for example, on subjects like:

Are you average?—what does it mean to be of average size?
Left or right-handed?—why are around ten per cent of us left-handed?
Standing on two feet—how do we keep our balance?
Cholera—a matter of life and death—the connection between cholera and clean water.
Brace up! — the western enthusiasm for bracing children's teeth.
Fit for something — the definition of fitness, and attacks stereotypes.
Going for a swim — the precautions we take when using a swimming pool.
No smoking, please — tackles this problem in a way that doesn't preach or criticise.
Zoo on you — the real truths about parasites and infestation.
Using energy in the home — an audit of fuel use.
Renewable energy.

In addition, there are units for older pupils on

HIV — misconceptions about AIDS.
Making the water flow — the work of WaterAid with African villages.
Free soap — the causes of a fictitious pollution problem in Zimbabwe.

How well does material like this travel? It can't be denied that some of SATIS 8-14 is specific to the United Kingdom in its context — not every country will be interested in traffic cones or electricity pylons, for example — but for children between the ages of 8 and 14, much of the SATIS material is intended for teacher support — for stimulus, inspiration, and good ideas. This makes SATIS 8-14 a valuable resource for any teacher of science, extending and refreshing their personal knowledge and understanding. It's other great strength is in its range of teaching strategies — which would make it a valuable resource for teacher-trainers, too. There are over fifty different teaching approaches in each box — ranging from true/false quizzes to carefully-structured role-play. SATIS 8-14 units have translated into Polish, Slovak and Japanese; they are currently being translated into Swedish, and adapted for use in Australia.

SATIS 8-14 is also available from the Association for Science Education at the address given above. It can be bought in North America from NSTA at 1840 Wilson Blvd, Arlington, VA 22201-3000, USA. There are three boxes — all low-cost, each with over fifty units of material and additional resources. Box 1 — the Green Box — is for pupils from age 7 upwards to around 10; Box 2 — the Yellow box — is for pupils from 9 to about 12; and Box 3 — the Blue Box — is for 11-14 year-olds and higher.

The Yellow box can also be bought as five theme books — Health, Environment, Technology, Materials and Transport.

New materials this year will resource teachers of the younger age ranges 3-6, and 6-8.

A recent review described SATIS 8-14 as 'inspirational' and 'motivating.' It concluded of SATIS 8-14 'Buy it — the price is right — and share it around for excellent value.' Why not look for yourself?

Enquiries about SATIS 8-14 are welcomed at the project office in Britain:

SATIS 8-14
University of Warwick Science Park
Coventry
CV4 7EZ
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THE STARTER EXPERIMENT APPROACH (SEA) TO TEACHING CHEMISTRY AND PHYSICS IN THE PHILIPPINES AND INDONESIA AND THE REST OF THE WORLD

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Preface (Ed van den Berg)

What do you do in a country where experiments are rarely used in Physics and Chemistry and where science is taught mainly verbally and frequently without textbooks but with an overcrowded curriculum, to classes of 45-65 students, where equipment is lacking, where students have never experienced the thrill of investigation and discovery and where many or even most teachers were trained in a discipline other than the one they are assigned to teach? How can you then involve teachers and students in experiments and how can you train the teachers? This time we present the answers of Dr. Jürgen Schönhere, a German consultant who spent more than a decade in in-service training in S. E. Asia. He asked me to draft an article based on a video tape of the method and his writings, and then saw the final draft, reacted, and approved.

The description provided below is particularly apt for the schools in South East Asia. However, both old and recent research data (Tamir & Lunetta, 1981; Germann et al., 1996) suggest that students are rarely made to go through the phase of conceptualization and design of experiments. Most experimentation is limited to measuring and some standard analysis following recipes. Here is a method which emphasizes design in a very systematic and manageable (for the teacher) and open (for the student) way.

The experiments are surprisingly simple and yet provide many opportunities for generating hypotheses which can be tested experimentally with very simple equipment (thus can be done in SE Asian classrooms). An example experiment is reported below.

Starter Experiments

In most countries overcrowded syllabi dictate what teachers do in the classroom. There is little or no room for experiments and what is taught and tested is mainly ‘content’ and little or nothing about the methods of inquiry. As we cannot easily change curricula, let’s do something which can be done within any curriculum. The basic idea is to start a new topic or chapter with a set of experiments, and perhaps not more than 3-6 times a year, but do it well. The other lessons on the chapter can just be taught whichever way the teacher is used to. A bird’s-eye view of the method is as follows:

Step 1: Students observe a demonstration experiment (here called starter experiment) and write observations individually.

Step 2: Observations are collected by the teacher and clarified by the students.

Step 3: The experiment is repeated to make observations more complete and to verify them.

Step 4: Students write ‘attempted explanations’ individually.
Step 5: Groups of students design verification/falsification experiments.
Step 6: Groups of students execute the experiments.
Step 7: Groups of students demonstrate their experiments to each other and report results.
Step 8: Students try to write conclusions with regard to the relationships between concepts involved.
Step 9: Students document the lesson in their notebooks and teachers make sure this is done properly.

The first lesson on a new topic starts with a demonstration experiment where all students observe. The reader may wish to read the description of the starter experiment which accompanies this paper.

Step 1: Observation. Each lesson following the Starter Experiment Approach (SEA) has to 'start' from looking at nature. The teacher must bring a bit of nature in to the classroom. This bit of nature is an experiment, easiest conducted by the teacher as a demonstration experiment. Sometimes it can be done as a student experiment, but that will require more preparation time of the teacher.

The materials used for the Starter Experiment should be taken—if possible—from the environment of the students. Special science equipment will be used later in the course of the lesson when students conduct their verification/falsification experiments. The experimental set-up should be simple and clear. The teacher must see to it that each student can make detailed observations, big classes will be grouped by the teacher and the groups will take turns for observation.

I want to discourage the very common, but useless naming of parts of the experiment (common in Asia). Instead students will learn to describe things they have not seen before in their own words. The name of the part will be given later by a student or the teacher when it has already been described by the student. This way we help students to improve their communication skills.

Students individually write all kinds of observations. Of course some of the observations are false and some are poorly worded. The teacher does not speak during this phase. When he or she feels that the students are missing out on something important, the teacher can demonstratively go near the experiment and do this observation. Students will quickly learn to understand our body language.

Since observations are the basis of all learning, the teacher must take utmost care that all students take part in this activity. There are a number of useful methods to achieve this:

1. The Starter Experiment should not contain unnecessary items.
2. The experimental set-up should be simple and preferably composed of materials and items taken from the students’ environment.
3. Students must have close access to the experiment for using as many senses for their observation as possible. The teacher must warn the students in cases where tasting, smelling, or touching is dangerous!
4. If the class is too big to allow all students close observation (classes in the Philippines can be 60 students or more) the teacher should group the class and let them take turns for observing the experiment (or use more than one set-up).
5. If necessary, the teacher must repeat the experiment to allow all students to observe properly.
6. Students should be advised to write all their observations down, preferably each observation on a separate piece of scratch paper. It is a good idea to let the students number their observations.
7. Students must not talk during the observation phase nor copy each others observations (somehow this is more easy to control in Asia’s big classes than in European small classes).

After all students have finished writing down their observations, the teacher starts to collect them. Again all students can take part in this activity if the teacher observes the following procedure:

1. One student is asked to read the first observation from her/his scratch paper.
2. The teacher takes this observation and asks who has noted the same thing, even using another formulation and collects them without reading them again.
3. One representative of the first observation is displayed on the board, either by writing it, or—to save time—by sticking students’ scratch papers on the board.
4. In the same manner, all the other observations are collected and for each new observation, one representative is displayed on the board, organized under each other in one column.
5. The teacher must watch out not to accept attempted explanations as observations. During the first few times the SEA is used, students usually have difficulties to understand the difference between an observation and an explanation.
Steps 2 and 3: After some discussion of the observations, the demonstration experiment is repeated to verify selected observations. Improvements of formulations should be made here if necessary, wrong observations are taken out or replaced by correct ones, missing observations are added. Students should now be given some time to sketch the experiment and note the observations into their notebooks. In the meantime the teacher selects those observations which are related to the concept and marks them by giving them big numbers. (In order not to discourage the students, the teacher must stress that observations not being selected are not bad or rejected, but that not all observations can be taken up at the same time and that some observations need not be explained since they are evident or trivial.)

Step 4: In this phase of the lesson again the students are working individually. For each of the selected observations they try to explain why these phenomena happen or can be observed. The students are asked to use separate pieces of paper for each attempted explanation. The teacher should stress at this point that it is not important that the attempted explanation of a student is ‘correct,’ but that it is important that each student must try to explain the phenomena with her/his own words and by her/his own ideas. Again the teacher must discourage the students to discuss their ideas or copy from each other.

Thus, the teacher has the opportunity to get to know students’ pre-concepts (a rare opportunity in lessons following traditional methods). This knowledge is important to actually confront the pre-concepts of the students with the more scientifically acceptable concepts at later stages of the lesson. Piaget nicely explained that the learner must feel a need to give up the pre-concept in order to replace it by a better one (restructuring).

Step 5: Verification/falsification. Students are grouped and each group is given one observation with the corresponding attempted explanations. Their job is to find out experimentally which of the hypotheses (attempted explanations) is correct, which one is wrong. As long as students are not familiar with SEA, the teacher is in high demand, helping students first of all understand the task, meaning analyzing the hypothesis and determining the parameter to be controlled (changed) and the other parameters to be kept constant (not changed). Inputs regarding equipment and procedure are also much needed in the beginning.

If possible the groups should not exceed five students, groups of three members are optimal. In case there are not enough observations, the attempted explanation for one or more observations can be split and given to two groups for verification/falsification. It is also possible to have two groups working parallel on one and the same set of attempted explanations.

I often observe that teachers have prepared verification/falsification experiments in advance, even sheets with the cookbook style procedure for the experiments were given to the groups. Though it is strongly suggested that teachers should try to anticipate the lesson they are planning, I would like to discourage the habit of ‘thinking for the students.’ Giving the students a ready made verification experiment plus the ‘User’s Manual’ is depriving them of a very important step of the SEA, the design of a veri/falsi experiment on the analysis of the attempted explanations. This very task is boosting students’ creativity, it cannot be skipped!

Step 6: Experiments are carried out. After the design and procedure for the ‘veri/falsi’ experiment have been approved by the teacher, the students collect the necessary equipment and start setting up the experiment. If sensitive equipment is involved, the teacher should require students to have their set-up inspected before starting the experiment. The teacher should always mention necessary precaution measures and give hints on how to conduct the experiment and how best to collect the data.

After conducting the experiment, the students have to write a summary on a big sheet of paper to prepare for the report to the class about their experiment and findings. The experimental set-ups will only be dismantled after the groups have given their reports.

Step 7: When all groups have finished their work, the teacher will ask all students to gather around the table of the first group. The group members will explain what they have done, starting with the original observation and ending with the findings of their veri/falsi experiment. The class then will have to interpret the results and decide whether the attempted explanations are correct or false.

The activity will be repeated until all groups have reported and all hypotheses have been assessed.

Step 8: Formulation of the concept. The teacher will ask the students to try writing draft formulations and conclusions for the concept(s) individually. For students still unfamiliar with the SEA it is helpful to collect some key-words first, noting them on the board. The students should be allowed to use their mother tongue if they have difficulties to translate their ideas into the official medium of instruction. The translation
can be done later and will serve the students as an additional language training!

For the final formulation of the concept, students and teacher will work together. It will be written in a prominent way on the board. Concept mapping might be appropriate at this stage.

**Step 9:** Fixing the lesson in students’ notebooks. At an earlier stage, the students have already sketched the Starter Experiment and noted the observations. Now they will add the attempted explanations and the veri/ falsi experiments by copying them from the report sheets of the groups being displayed in the classroom and the final formulation of the concept.

The teacher should make the students understand that this work of documenting the proceedings of the lesson is important, because it constitutes a reference for them for the future. Students who do a good job at keeping good lesson records should be singled out for praise. Please note that this is even extra important in classes where many students do not have textbooks.

Postscript (Ed van den Berg)

In the hands of good teachers, the SEA works very well in the classroom, even in the large classes in the Philippines and Indonesia. However, it does require sufficient time for training and it does require a certain minimal level of subject matter mastery. Without that teachers do not feel confident to use it. In a future article we hope to report more on teacher training methods. Schönherr has developed a certain training strategy he calls the “Model-Transfer-Strategy” which was developed over the years and has turned out to be effective in developing countries.

**Endnotes**

1. The Starter Experiment Approach and the accompanying teacher training strategy were developed while the first author worked at the National Science Teaching Instrumentation Center (NSTIC), Suldon, Lahug, Cebu City, Philippines. NSTIC is a joint effort of the Philippine and German governments.

**References**


**Figure 1**

**Beaker A:** Water with ice cube  
**Beaker B:** Oil with ice cube
Lesson 1: The Starter Experiment

The teacher simultaneously places an ice cube of similar size into each of the 2 beakers, one containing water and the other containing an equal volume of cooking oil (Figure 1). Please do not explain the set-up like “This is a beaker, it is filled with water, that is an ice cube.” All these are part of your students’ observations!

A list of possible observations could be as follows:

<table>
<thead>
<tr>
<th>Beaker A</th>
<th>Beaker B</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Liquid is colorless, odorless and tasteless.</td>
<td>1. Liquid is greasy, yellowish and smells fragrant.</td>
</tr>
<tr>
<td>2. The level of the liquid rises when ice is placed in it.</td>
<td>2. Same observation as in beaker A.</td>
</tr>
<tr>
<td>3. Ice floats in the liquid.</td>
<td>3. Ice sinks in the liquid.</td>
</tr>
<tr>
<td>4. Bubbles generate from ice and while increasing in size move rapidly upward to the surface.</td>
<td>4. Tiny bubbles from somewhere near the surface fall very slowly towards the ice.</td>
</tr>
<tr>
<td>5. The container feels cold.</td>
<td>5. Fine white particles accumulate or hold on to the exposed surface areas of the ice, forming a cotton like appearance.</td>
</tr>
<tr>
<td>6. Moisture appears on the outside surface of the container.</td>
<td>6. The outside surface of the container remains dry.</td>
</tr>
<tr>
<td>7. Ice completely melts within 3 minutes.</td>
<td>7. The bottom of the container feels colder than its upper portion.</td>
</tr>
<tr>
<td>8. A single-phased liquid is observed.</td>
<td>8. Bubbles generate from ice, one at a time and move towards the surface.</td>
</tr>
<tr>
<td></td>
<td>9. Ice gradually melts while solid particles of oil disperse and melt into the liquid.</td>
</tr>
<tr>
<td></td>
<td>10. Ice completely melts within 3 hours.</td>
</tr>
<tr>
<td></td>
<td>11. Two layers of liquid are formed, oil on top of water.</td>
</tr>
</tbody>
</table>

These are the essential observations. Students may observe other phenomena like reflections or movement of the liquid. That is fine and they should be encouraged to observe whatever there is to observe.

Actually, after the repetition of the experiment and the observations, students could sketch and describe the experiment in their notebooks and copy the observations. Then the formulation of attempted explanations could be done as home work.

Lesson 2

Discuss first the different explanations the students come up with from their homework. Group the student explanations with the observations they are trying to explain. Do not comment on the correctness of the explanation.

There will be possible explanations with regard to the following questions:

a) Why do the levels of the liquids in both beakers rise when ice is placed?
b) Why does ice float in liquid A and sink in liquid B?
c) What causes the formation of bubbles when ice is placed in liquid A?
d) Why do bubbles rise faster in liquid A than in liquid B?
e) Why is the outside surface of beaker A colder than the outside surface of beaker B?
f) Why does ice melt faster in liquid A than in liquid B?
g) Why does moisture appear on the outside surface of beaker A but not on beaker B?
h) Why does a white cotton-like substance form around the ice in beaker B?

For example, question e) might be related to g) and could be explained by:

e1: In beaker A ice readily absorbs heat from the liquid and its container whereas in beaker B absorption of heat is obstructed by the presence of the cotton like substance around the ice; and/or
e2: The liquid in beaker B may be a poor conductor of heat;
g1: Water vapor in the air condenses rapidly on the outside surface of beaker A forming moisture because of the very low temperature of the container.
Student explanations are grouped according to similarities. Groups of students are assigned to design verification experiments for the different explanations. This could be continued as homework.

Lesson 3

Groups present the designs for the verification experiment. Then equipment is distributed. Students then carry out their experiments. To investigate explanations e1, e2, and g1 students could:

1. Take the initial temperatures of water and of oil.
2. Repeat the starter experiment.
3. Take 10 temperature readings in both containers at intervals of 10 seconds.
4. Compare the temperature readings near the ice and near the glass in both containers.

Similarly students would have alternative explanations for the other questions (a-h listed above) and procedures could be designed for verification/falsification experiments. For example, question h) might elicit an explanation involving the freezing of oil around the ice. One could investigate this further by dipping a test tube with oil in an ice bath and observing whether a similar cotton like substance forms. Then students could prepare for reporting their results in a presentation to the class.

Lesson 4

Different groups report to the class and then time is spent on concept formulation (for example, formulating propositions which involve the basic concepts). Finally in the lesson or in homework students write an individual summary of the steps carried out during the last four sessions.

British Council International Seminar
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The seminar will explore different rationale for technology education in the school curriculum, and the traditions from which they arise in different countries.
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The British Council
The British Council, registered in England as a charity no. 209131, is Britain's international network for education, culture and technology
Physics Infomall is an impressive library for physics education on a CD-ROM. The “library” originated from a project to assist the many unqualified physics teachers (over 30%) in American high schools. Many of these teachers are working as the sole physics teacher in their rural schools, there are no qualified colleagues who can assist or answer questions or supply ideas. So the idea was to prepare a large library of ideas for them culled from books and journals in physics education. The National Science Foundation funded the idea. A team under the guidance of Bob Fuller of the University of Nebraska and Dean Zollman of Kansas State University went to work and so Physics Infomall was born.

As most of the references are taken from journal articles which have been written for an audience of qualified/trained physics teachers (BS level and beyond), Infomall has much more information to offer to the qualified physics teacher than to the unqualified one. The latter will often run into texts which are just beyond his/her level. Infomall is certainly not a solution for the many unqualified and underqualified physics teachers in S.E. Asia who will need a lot of physics training to be able to benefit from Infomall, let alone in those countries where English is not used much. A listing of which information sources in Infomall to use and which ones to avoid might solve the problem for the mildly underqualified physics teachers (e.g., avoid the American Journal of Physics references if you do not have the equivalent of a BS Physics).

System requirements

Physics Infomall is available for both DOS-Windows and Macintosh. The minimum system requirements are: any IBM-PC compatible computer which has at least 2MB of RAM, Windows 3.1 or higher, 2MB of free space on the hard drive, and a CD-ROM drive. Recommended is an 80386 or higher with a minimum of 4 MB of RAM and a hard drive with at least 4 MB of free disk space. We ourselves tried out the Windows version on a 100 MHZ Pentium with Windows 95, an 850 MB hard disk, 16 MB of system memory.

The Contents of the CD-ROM

The CD-ROM was very easy to install (the trial version had been more difficult) under Windows 95. When entering the program one arrives in shopping mall where one can choose to enter stores like:


b. The Book Basement with 11 books such as the well known How Things Work by Richard Crane who regularly writes articles explaining the physics of every day apparatus such as the fluorescent lamp or the photocopier, Teaching Physics: A Guide for the Non-Specialist by Osborne and Freeman, a very useful book written particularly for non specialist physics teachers in UK, Biography of Physics by well known joker and Nobel price winner George Gamov, and the thoughtful Guide to Introductory Physics Teaching by Arons.

c. A Calendar Cart of events in physics history, nice to edit yourself and print a monthly calendar for display in the classroom.

d. A Catalog Collection with catalogs of three major equipment suppliers.

e. A Utility Closet with various useful things such as a list of constant, the periodic table and various other materials.

f. Demo & Lab shops with several well known laboratory books such as the Demonstration Handbook for Physics by Freier & Anderson and The Castle Project for teaching about electric circuits of Steinberg et al.
g. *Pamphlet Parlor* with various small booklets such as products of the AAPT Physics and Technology Modules (The Bicycle, The Camera), the AAPT Guidelines for Teaching High School Physics, etc.

h. *Problems Space* with various sources for problems.

i. *Study Guide Store* with study and teacher’s guides.

j. *Teachers Treasures* with contributions from various teachers including demonstrations, activities, and quizzes.

k. *Textbook Trove* with nineteen textbooks including *Physics for the Inquiring Mind* a classic innovation of the 1960s by Eric Rogers, one of the men behind the big curriculum projects of the 1960s.

l. A list of physics specialists and teachers who are willing to answer questions from Infomall users. This feature was typically incorporated considering the American target audience of under-qualified, lone physics teachers in rural high schools.

m. There are tables of contents of some popular textbooks which are in print and popular (e.g., Hewitt’s Conceptual Physics) for which no permission could be secured for inclusion on the CD-ROM.

The Search Engine

The search system is easy to use. Specify one of the sub-categories (a-m above). Type key words like *refraction or super-conduction, or computer assisted instruction* and the computer tells you how many references it found. One can then specify additional keywords to narrow down the search, or one can start browsing. Obviously not every word works, there is a list of keywords for the search system. We tried to look for references on safety and electrical installation and did not find any. It turned out that the AAPT2 data base (see below) did not give any references either. So good chance the AAPT journals which constitute an important resource for the CD-ROM never contained an article about the subject. However, most other words we tried generated lots of “hits” and interesting readings.

Price and ordering

The price is US$ 295—and having it delivered Federal Express cost us another US$51—but did save us all the trouble of import and import tax, etc. In many countries having the CD mailed as a book in an envelope would be cheap and also save customs trouble. The price is high, but the price of all the articles and books contained on the CD is obviously a multiple of this amount and, actually, quite a few books are not easy to get or perhaps not in print anymore. A first inquiry about a special price for Asia did not produce a sensible answer. However, when we contacted the supplier again recently, he seemed to be willing to offer a special price if there would be a market. A collective order might bring the price down quite a bit. Infomall is now marketed and sold by:

*The Learning Team, 84 Business Park Drive, Armonk, NY 10504*  
Fax: 914-273-2227 Telephone: 914-273-2226

A CD-ROM in the age of Internet?

One might wonder what to do with a CD-ROM. Much information is available from Internet nowadays, are not CD ROMS like this already outdated? Well, we are not so sure what is available on the Internet as we have only a 64 kB link from our university while our modem is only 14.4 kB. We are far from the superhighway and small access roads are choked. Many other physics lecturers are farther yet from Internet than ourselves. Another argument is that the team producing the CD ROM has made a useful selection while at the Internet one would have to do a lot of looking around.

Another alternative for searching for information on physics education is the data base for the *American Journal of Physics* and *The Physics Teacher*. The data base is available from the American Association of Physics Teachers (AAPT) for US$32. But this data base will only provide references to articles and not the articles themselves. This data base is useful if one has the two journals in the library, but not if one only has recent issues or no subscriptions to the two journals at all. The AAPT data base requires about 12 MB of hard disk space and comes in three diskettes.

Development and production

The developers had a tremendous job contacting all the individual authors of the thousands of articles on the disk. I myself received a special form for a one page article my wife and I published years ago. One can imagine the problems in getting all these forms back and in negotiating permission from authors and publishers for reproduction of complete books. Then there was the job of getting the texts on disk. Scanning turned out to be too unreliable. So typists in the Dominican Republic and in the Philippines typed in all the text. Each article was typed twice (different typists...
and different countries) and then a computer program checked the discrepancies and that way typing errors were discovered and corrected easily. The obvious assumption was that two typists are not likely to make the same error. Presumably spelling checkers were used as well.

**Original books and journals and the CD-ROM version**

This production process with all the re-typing means that the book and journal pages on the screen do not look like the ones in the originals. The screen contains the same text, but not in the same pleasant layout as in the book. Furthermore, figures are separated from the text although easily available with a click of the mouse. Figures are also at a much lower resolution than in the original articles, otherwise they would not fit on such a comprehensive CD-ROM. All of us would probably prefer to read from the original book or journal rather than from a computer monitor. However, if one does not have the original books and journals, or cannot get out-of-print classics contained on the disk, the CD ROM is a nice and cheap alternative. And, of course, the primary reason for publishing on CD-ROM rather than on paper is not as an alternative for reading books and journal articles, but for making searches possible and finding answers very quickly.

**Other possibilities and comments**

One can also copy and paste. For example, when one is making a problem worksheet, one can look for problems and copy and paste them into the worksheet. Or when writing laboratory instructions, one can copy and paste from the laboratory and demonstration manuals. When writing a hand-out about solar radiation recently, we copied a description of the electro-magnetic spectrum from one of the textbooks contained in the "textbook trove." Unfortunately superscripts and subscripts get copied as regular text, so one does have to screen copied text carefully to restore special symbols. We also tried to copy figures, but still had some trouble. Figures can be rotated over various angles, they can be enlarged or reduced to different sizes, but we had some trouble copying them and did not succeed in printing. That problem is probably our own problem rather than Infomall’s. We will just have to try again and learn more about processing of graphic information.

All the books listed in the appendix can be accessed and basic program operations seem to work properly. However, there are some special features which do not yet function but there is a proper message so one does not get stuck.

There are also graphics where one gets a message that the graphics have not been included, either because it would take too many bytes of storage, or because no permission was granted to include the graphics. The pictures from the book Crystals and Crystal Growing did not come to the screen for that reason. Quite understandable, beautiful photographs of grown crystals would take too much storage. Disappointing of course.

**The User’s Guide**

There is not much we can tell you about the user’s guide as the CD-ROM is friendly enough, so one does not really need the User’s Guide. We only used the installation instructions and for the rest just ran the program from the screen. Only now when writing this paper we started looking in the User’s Guide.

**Summary**

**Advantages:**
- A large and useful library is now available on a small disk for a reasonable price.
- The search system can find answers to questions in seconds and link many references.
- The disk is portable and can be brought anywhere on travel for workshops etc.—a pleasant alternative to bringing a suitcase with books.
- Parts of texts can be easily worked into one’s own laboratory worksheets or other lesson materials (of course mentioning the original source and giving credit to original authors).

**Disadvantages:**
- The price . . . expensive for Asia, but a discount can be negotiated when people order collectively.
- Reading from paper is more pleasant than reading a computer screen.
- The resolution of figures and photographs is poor.
- In copied text super- and subscripts show as normal text and need to be restored manually.
- Basic features work well, a few special features do not function yet but there is a proper warning.
- The collection of test questions is too limited.
- There are a few little errors, but not disturbing.

On balance, Physics Infomall constitutes a beautiful and useful resource for every University Physics Department and Library and for high school
teachers with a good physics background. We are happy with our purchase of Physics Infomall.

Endnotes

1. Ed van den Berg and Nelson Rosaroso are connected with the Science Teacher Education Project Southern Philippines (STEPS), which is a joint effort of the Vrije Universiteit in Amsterdam (Netherlands) and the University of San Carlos (Philippines) and the Netherlands government.

2. AAPT: American Association of Physics Teachers.

June 21-24, 1997
International History, Philosophy and Science Teaching Group
North and South America Regional Conference
Calgary, Canada

A regional conference of the International History, Philosophy and Science Teaching Group will be held in June 21-24, 1997 at the University of Calgary, Calgary, Canada. The Dean of the Faculty of Education, Professor Ian Winchester, will be the conference chair. Although a regional conference, all members of the International Group, and others, are welcome to attend. Calgary is situated at the foot of the Canadian Rockies, near to the mountain resort of Banff. The conference programme will include an optional visit to the Rockies.

International and national groups that have interests in the role of HPS in science, mathematics and history teaching are encouraged to use the conference as an occasion to present their work and to consolidate networks.

Proposals for contributed papers, workshops, discussion groups, and exhibits of curricular and instructional materials related to the purposes of the conference are now being accepted. Four copies of the proposal or paper should be sent to Ms. Linda Lenz at the address below. The proposals should include:

1. A cover page with paper title, authors name(s), institutional affiliation, address, telephone numbers, FAX number, and e-mail address.
2. A 100-150 word abstract of each proposed paper or session.
3. Three self-addressed envelopes.

Due date for receipt of papers and other proposals is February 15, 1997.

Format:
Papers should follow the format, style and referencing conventions used in the group's journal Science & Education. Please pay particular attention to form of title, authors name and address, an Abstract of 100-150 words, referencing conventions. Disc submission is necessary. WordPerfect or Microsoft Word for PC or Mac platforms is preferred, but ASCII is acceptable.

Final papers should not exceed 5,000 words. They must be submitted by February 15, 1997. Early submission of proposals and final papers is encouraged in order to facilitate programming and production of Conference Proceedings.

Journal Participation:
It is anticipated that some scholarly journals Interchange and/or Science & Education will publish special issues related to the conference. To be considered for these issues, papers need to be forwarded by October 31, 1996.

Proposals and papers should be sent to, and registration information can be obtained from:
Ms. Linda Lenz, Faculty of Education
University of Calgary
Calgary, Alberta
Canada, T2N 1N4
E-mail: hpsst@acs.ucalgary.ca
January 23-26, 1997
Fifth Annual Meeting of the Southern African Association For Research In Mathematics and Science Education
University of the Witwatersrand, Johannesburg, South Africa

The Local Organizing Committee, on behalf of the Southern African Association for Research in Mathematics and Science Education, cordially invites all science and mathematics educators interested in research in these fields to join us at the FIFTH ANNUAL MEETING of SAARMSE.

The meeting will be held on the West Campus of the University of the Witwatersrand, Johannesburg. Accommodation will be provided in Barnato Hall, the new university residences which is just a short walk from the conference venue, the New Commerce Building.

Aims of the Conference:
1. To foster a sense of community cooperation amongst researchers involved in mathematics and science education in Southern Africa.
2. To provide a forum for debate and discussion on research methods and research findings.
3. To assist in the development of research skills of new researchers entering this field of research, and to develop further expertise in those already involved, by means of capacity-building workshops, discussion and debate.
4. To make research available and accessible to researchers, educators, curriculum designers, and policy-makers.
5. To provide an opportunity for liaison between stakeholders interested in science and mathematics education.

Capacity-Building Strategies
We are making a special effort this year to help inexperienced researchers to develop their research and presentation skills.

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College of Science
P O WITS
2050 SOUTH AFRICA
Tel: (011) 716-2679
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March 12-19, 1997
British Council International Seminar
Technology Education in the Core Curriculum
Directed by Prof Paul Black and Justin Dillon

The seminar will explore different rationale for technology education in the school curriculum, and the traditions from which they arise in different countries.
Main themes will include:
• technology as appliance of science or as design
• preparing a citizen for a technological society
• basis for a better educated workforce

The programme will be of particular interest to those responsible for curriculum, development and teacher training.

Seminar Fee—1750 Pounds sterling (residential)

For further information contact:
Promotions Manager
International Seminars Dept
The British Council
1 Beaumont Place
Oxford OX1 2JP, UK
Fax: 44-1865-557368/516590
E-mail: International.Seminars@britcoun.org

March 24 or 28, 1997
XIXes JOURNEES INTERNATIONALES

Sur la Communication, L'Education et la Culture Scientifiques et Industrielles
Elles se derouleront du lundi 24 au jeudi 28 mars 1997 au Centre Jean Franco a CHAMONIX.

Andre GIORDAN
L.D.E.S., Uni. Geneve
Bat B 9, route de Brize
1227 Carouge-Geneve (Suisse)

May 26-30, 1997
Science Globalizes: Search for Global Goals of Science Education
International Conference on Science Education,
Seoul, Korea,

The conference, organised by KEDI (Korean Educational Development Institute) and co-sponsored by ICASE and UNESCO, has as its theme 'Common Problems/Questions in Science Education Around the
World: Moving Toward Worldwide Science Education Standards.’

The conference will focus on discussion and debate concerning the following six themes using current research and common practices.

1. Defining appropriate science for all: What is meant by appropriate science for all?
2. Learning: how do humans learn science?
3. Teaching strategies: What form of teaching is required for science?
4. Assessing learning: How can we determine that learning has actually occurred?
5. Needed resources: What materials will promote systemic reform?
6. Building partnerships: Who are the needed allies in solving the problems?

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The Symposium will be held in Lublin, a town situated about 170 kilometers south-east of Warsaw. It is easily reached by train or bus (travel time: 2 and half hours). Lublin is considered one of the oldest settlement sites in Poland. It is a large industrial and commercial centre, as well as scholarly, cultural and a tourist one.

The Symposium language is English, however, the organizers will provide some help (interpretation into Polish and Russian) for the participants from the East European countries.

Registration fee: 30 USD (IOSTE members 20 USD)
The organizers will do their best to make the participation costs (accommodation and meals) of the Symposium as small as possible.

For further information contact:
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June 21-24, 1997
International History, Philosophy and Science Teaching Group
North and South America Regional Conference
Calgary, Canada

June 2-5, 1997
Second IOSTE Symposium for Central and East European Countries Science and Technology Education For Social And Economic Development
Lublin, Poland

The problems discussed during the Symposium will include:

• Development of knowledge in science and technology indispensable at the turn of the millenia.
• Changes taking place in a way of thinking of dents being affected by science and technology education.
• Prospects and citations of integration in science and technology education. Studies in development of cognitive abilities in science and technology education.
• Common research problems in physics, chemistry and biology education.
• Regional cooperation in the field of science and technology education.

A regional conference of the International History, Philosophy and Science Teaching Group will be held in June 21-24, 1997 at the University of Calgary, Calgary, Canada. The Dean of the Faculty of Education, Professor Ian Winchester, will be the conference chair. Although a regional conference, all members of the International Group, and others, are welcome to attend.

Calgary is situated at the foot of the Canadian Rockies, near to the mountain resort of Banff. The conference programme will include an optional visit to the Rockies.

International and national groups that have interests in the role of HPS in science, mathematics and history teaching are encouraged to use the conference as an occasion to present their work and to consolidate networks.

Proposals for contributed papers, workshops, discussion groups, and exhibits of curricular and instructional materials related to the purposes of the conference are now being accepted. Four copies of the
July 19-July 4, 1997
CONASTA 46
Annual Meeting of the Australian Science Teachers Association
University of Melbourne

Science Down Under--Extending the Boundaries. Our aim is to provide science teachers with up-to-date cutting edge information on the thinking of Australian scientists and near neighbours. The programme will also highlight practice and theory suitable for all levels of science education. It is our intention to extend the boundaries of knowledge.

For more information contact:
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PO Box 190, Richmond, 3121
Tel.: (03) 9428 2633
Fax: (03) 9428 4876
E-mail: stav@netspace.net.au

October 1-5, 1997
8th International Conference of ISATT (the International Study Association on Teacher Thinking)
Kiel, Germany

The Conference theme is “Teachers’ Work and Professional Development.” The work of teachers is changing due to systemwide policies, global economic and technical trends, equity issues and changes in the nature of school subjects. These trends place teachers in new roles. How do teachers respond? In times of change it is important to consider the implications for the individual, social and cultural development of the teaching profession. What now constitutes, “professional” development? What is the impact of research and curriculum development?

Registration fee will be 400 DM for nonmembers and 350 DM for ISATT members or students.

Information about the forthcoming conference are provided on the Internet:
http://www.ipn.uni-kiel.de/isatt

You may also contact:
Dr. Manfred Lang (chair Program Committee)
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E-mail: langm@ipn.uni-kiel.de
Extending and Improving Education in Science
for All Children and Youth by Assisting
Member Association Throughout the World

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Science Education International is the Quarterly Journal of the International Council of Associations for Science Education. ICASE was established in 1973 to extend and improve education in science for all children and youth by assisting member associations throughout the world.

This journal provides means for associations, institutions, centres, foundations, companies and individuals concerned with science education to share perspectives, concerns, ideas, and information which will foster cooperative efforts to improve science education, and which will serve as a chronicle of the advancement of science education throughout the world.

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Dates for Receipt of Contributions

<table>
<thead>
<tr>
<th>Issue</th>
<th>Closing Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>March</td>
<td>1 February</td>
</tr>
<tr>
<td>June</td>
<td>1 May</td>
</tr>
<tr>
<td>September</td>
<td>1 August</td>
</tr>
<tr>
<td>December</td>
<td>1 November</td>
</tr>
</tbody>
</table>

ICASE News .................................................. 2
Feature Article ........................................... 3
Science Education Around the World .............. 7
Research on Curriculum, Teaching, and Learning ........................................ 16
Teaching Materials and Strategies .............. 20
Science Teacher Education and Leadership .................. 26
Assessment and Evaluation Trends ............ 30
Non-formal and In-formal Science Education ........... 33
Calendar ...................................................... 39

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ICASE News

This section provides news for the information of member associations, institutions, centres, foundations and companies. The Executive Committee encourages members to reproduce this section in journals and newsletters to communicate this information to as many as possible.

Educational Research in Chemistry and Physics Education

The 5th international symposium on science education research was organized in the University of Dortmund by Prof. Hans-Jurgen Schmidt in May 1996.

This series of symposia has become well known among science educators and researchers, as offering an insight into the relationship between research and teaching. ICASE has been involved with all the symposia having published the proceedings each time for wider dissemination among ICASE members and more widely.

The programme for this symposium included papers from researchers from many countries, within and outside Europe, including two significant papers from Taiwan and one from Mozambique. The proceedings will be available early in 1997 from ICASE; details will appear in this Journal.

This symposium is the last in the series to be held in Dortmund because the initiator and organiser, Hans-Jurgen Schmidt, will be retiring from his post in the University before the next symposium is due in 1998. ICASE has already recognised the contributions that Hans-Jurgen Schmidt has made to international science education by awarding him, in 1995, the ICASE Certificate for Excellence in International Science Education, and would like to pay special tribute to his work in Dortmund for this series of symposia. The next symposium will be held in Utrecht in 1998, and will be organized by Dr. Otto de Jong, a regular participant in the Dortmund symposia. Details of this next symposium will be available to all interested researchers and will be announced in the columns of the ICASE Journal in due course.

1999 Science Links Year

ICASE, in conjunction with the ASE in Britain, is planning a major scheme for linking schools throughout the world in the year 1999. The idea is that groups of science students from different cultures can work together on selected projects—sharing ideas and learning about each other as well as their science. Many schools already have links with schools in other countries. This scheme for 1999 is designed to build on this experience and to encourage other schools to establish links to develop science-related projects. There will be an opportunity for the best projects to be displayed at a special meeting in 1999, probably in London.

Details about the scheme, which will be coordinated by national science teachers' associations, may be obtained from the President-elect of ICASE or the ICASE Treasurer (see inside front cover for addresses), from the ASE in Britain (ASE, College Lane, Hatfield, AL10 9AA, UK) or from the appropriate national science teachers' association. More information will be published in the ICASE Journal later in the year.
The Need

The students for the new millennium must be an active problem solvers, prepared to function in a highly technological and computerized world. They will need to develop the skills and the literacy to make effective use of computers and electronic information network to learn about new scientific discoveries, and to problem solve around emerging concerns. It has become increasingly important that the students recognize and appreciate the interaction of science and technology and their cumulative effects on society, and to recognize and appreciate the importance of sustainable development. Students need to realize that technology and scientific research present problems and that we have the capacity to determine solutions.

Traditional methods of teaching science curriculum do not adequately prepare our students for the 21st century. Teaching science curriculum needs to be more than the presentation of laws, theories, science concepts and facts. A measure of a student’s success should not be based on more than her/his ability to regurgitate these facts. Students must become active rather than passive participants in their own education. They must be prepared to discuss issues that will affect their lives and to arrive at possible solutions to these issues. They must be willing to look at alternative solutions to issues and to decide which alternatives will be acceptable.

There are many STS, SD, and STL issues of concern in today’s society. Threats to our environment, our atmosphere, and our energy supply, are but a few areas of concern about which our students should be thinking. How to deal with the explosion of technological devices and processes is a challenge to all. Society is demanding that the scientists of the future have both ethics and a conscience. To develop this, our students should be encouraged to look carefully at this important interdependence of science-technology-society and to become both scientifically and technologically literate. This can be accomplished by having the students research issue topics, share their information and arrive at possible answers to these issues.

For students to become effective problem solvers, teachers need to provide them with a structure or framework that they can follow. This became evident during year 1 of the project. Although the topic was introduced and students were given ideas as to how the topic might be approached, they were not given a framework for independent problem solving to guide them. Their research was sound but the essays were mainly descriptions of the issues, with few answers being presented. I realized that to help students come to higher levels of analysis and synthesis some direction on how to develop acceptable alternatives and answers to the issues was needed. There are a few students in each group who do not require a framework. These creative individuals develop there own framework.

The Program

Issues and Answers: A Problem Solving Approach

To respond to this need, a team of teachers have been developing and evolving an ethical research program for senior high students at Miles Macdonell Collegiate in Winnipeg, Manitoba. The program is the result of coordinated efforts over the past six years between a science teacher, a teacher-librarian, and a computer technician. The chemistry teacher was responsible for discussing STS and the generation of topics for research and evaluation. The teacher-librarian instructed the students on research techniques, referencing, copyright, and writing strategies. The computer technician exposed the students to the different software programs that were available to them in the resource computer system and helped the students with files and their final publication. All three members were involved in developing a knowledge base of student files to be stored in the computer system.

We wanted a program that would provide a framework for student work and would enable the students to make choices and have options. With this...
kind of program flexibility, the student could choose to apply part of the program or opt for the total package. Several models for research and writing programs were critically analyzed. Amongst the most informative was the curriculum for study of bioethical issues by Iozzi (1982). This program developed in 1982 established the framework for our program. In 1992, we incorporated the work of Toews and McCrath (1990) and put the Issues and Answers program into a computer format. In one year, we went from pen and paper projects to a computer-based program. The result of our work was a program in the computer which students could work through individually to assist them with research, analysis, synthesis and solution formation. Students then went on to use technology as a tool for their final work and presentation.

Issues and Answers: A Problem Solving Approach

The following is a brief description of the major headings of the Issues and Answers program. Each topic is quite comprehensive with specific directions and questions to help the students with their research, analysis, synthesis and presentation.

Understanding the Issue. This introductory section is designed to help the student focus on the task at hand. Students fill in a questionnaire identifying the major "players" or stakeholders, the scope of the issue and possible alternative solutions to the issue. Throughout the gathering of information and the synthesis stages, the student refer back to this section and make any necessary adjustments. This provides a focus or the direction to the project.

Researching the Issue. There are many sources from which students can gather information, CD's, books, magazines, Day Media Files, Internet, videos, audio tapes, personal interviews. The objective is to find appropriate materials and to keep a record of the important facts for future use in presenting arguments and possible answers or solutions.

Creating files. One way to keep these records is to produce personal files of information. It is important that each text file be in the student's own words. These statements can then be used directly by the student in analysis, synthesis and final presentation of the project, with little or no change in text. Students are encouraged to keep an accurate account of where they obtained the information. This is needed for end notes, footnotes, and bibliography.

Analysis and synthesis of file information. A student creates an analysis sheet which contains the main headings from the research. Using the "copy" and "paste" functions on the computer, information is transferred from files to the analysis and synthesis sheets.

Determining important values. The analysis sheets may contain values or ethical categories which contain both positive and negative arguments. Students are encouraged not to state their own opinions but to gather the opposing opinions from their research. The students do not need answers for each of the categories listed in this section. They only use those sections which apply directly to their project.

Alternative actions. Students should look for alternative actions to their issues, rather than concentrating on one action. These actions might be some which are already in practice or they could be actions that the experts proposes for the future. Students may make choices as to which alternatives are realistic and possible to implement.

Presentation of Results

There are various ways that the student can present the project:

- a written essay
- essay format with pictures
- multimedia software such as Director, PowerPoint, HyperCard, HTML

The presentation method chosen will be determined by the categories and materials to be presented. For example, if the student has several pictures and the text is straightforward, use a simple processor presentation with text wrap function. If the topics are related and are best presented as separate topics, the student may choose to create a multi-media, interactive presentation.

The Project

Early in the semester, students are exposed to the Issues and Answers program and are given a list of possible research topics. Working in pairs, each group of students will select one issue for research. Students do have the option of proposing their own issue. Prior to starting their research, the students undergo a two period training session to prepare them to deal with information obtained by audio, visual, and electronic means. We have found that students are adequately trained to handle hardcopy but they are not as competent when the information comes from videos, television, audio tapes, CD's or Internet.
Files are an integral part of the project and a certain percentage of the final grade comes from the quality of the student's files. The files are retained in our own information base, InfoBase, in a central computer. These files are invaluable in assisting the next generation of students with their projects. The files provide the students with a base from which to start their research.

Students are requested to have approximately ten pages of single spaced text for their final presentation. This text can then be altered and placed into different software programs. At this time, the computer teacher may spend many hours after school, and even on weekends working with the students. The project is completely paperless.

Results

For the past six years I have been collecting and saving student project work to use as a baseline for evaluation, and as models for student use. Over the this period of time, there has been a steady improvement in the quality of research and presentation. We attribute this improvement to the incorporation of the problem solving framework and the integration of technology. Student projects have far exceeded our most ambitious expectations. The quality of work has been steadily improving with each new group of students. Each new class is presenting a more sophisticated project than their predecessors. Many of our graduates have returned to the school with positive comments about the project. They are neither frightened nor intimidated by projects assigned to them at universities or colleges. One student in particular was reluctant to participate in the project while at our school, and contemplated transferring to another chemistry class. He wrote the team a letter from his university thanking us for teaching him how to research and write papers. This English Second Language (ESL) student obtained a mark in his first university essay that was in the top 10% of the class.

Information Base (InfoBase)

An information base is created by using student files. A file may be an abstract, graph, chart, scanned picture, a computer generated picture, or digitized audio or video materials. Every file generated by the student is not automatically entered into the base. The file must have sufficient information and be constructed in an acceptable manner. Instructions are given as to the different methods of producing acceptable files. Each file must be run through the system spell checker to eliminate spelling errors.

The Miles Macdonell InfoBase contains over 2000 files covering over 60 topics in chemistry and biology. We also retain complete student projects in the InfoBase. This provides new students with examples that they can look at and follow. The project becomes less intimidating when they see what fellow students have accomplished.

At present, the base contains approximately 100 final presentations. Many of the presentations are multimedia, developed by using both IBM and Macintosh software packages. Students are asked for their permission to allow their work to remain in the InfoBase. They are informed that their projects cannot be distributed without their consent.

Project '97: Sustainable Development

The Issues and Answers program will provide the research and problem solving framework for a joint, three-school project on sustainable development. Students from Miles Macdonell Collegiate will become involved in sustainable development research with students from two rural schools, Steinbach Regional Secondary School and Neepawa Collegiate. A pilot project involving Miles Macdonell and Steinbach will occur during the 1997 spring semester. Students from Neepawa Collegiate will enter into the program in the 1997 fall semester.

The pilot project is both interdisciplinary and student interactive. This interdisciplinary project will involve students from Technical Writing 40S and Chemistry 40S classes. Students will be presented with nine sustainable development issues. Working in pairs, they will choose one topic for research. Students working on the same projects from three different classrooms will communicate using Internet, E-mail and conference calls. They will have access to the project teachers from both schools. Completed projects will be added to the InfoBase: Exemplary projects will also be added to the student work section of our School Home Page on Science.

The pilot project was launched with a sustainable development forum held at Miles Macdonell Collegiate, February 1997. During the morning session, students heard presentations from a panel which included a provincial cabinet minister, an environmentalist and a member of the business and industry community. Students had opportunities to pose questions to the panel. During the afternoon, the students interacted in a round table simulation on environmental issues. Students assumed roles of stake holders in the issue and were able to observe first hand the process of trying to
reach a consensus on a controversial issue. In addition, students from the two schools had an opportunity to meet informally with co-researchers. A meeting is planned for May, 1997 at Steinbach where the students will present their topics and have closure to the project.

The project is expected to expand to include 40S geography class form Neepawa, in the 1997 fall semester. The students at Neepawa are taught by ICASE Past-President, Robert (Bob) Lepischak. Students from three distinct regions on Manitoba will be linked by technology, and will share research experiences as they attempt to solve issues which may help ensure a sustainable world for tomorrow. The global village is fast becoming a reality.

Neither Issues and Answers: A Problem Solving Approach, nor Project '97 would be a reality without the collaborative effort of many people. The following educators have been involved or are presently involved in these endeavours:

Ernest Kuch  
Program developer, Project team leader at Miles Macdonell, Chemistry/Biology teacher, Winnipeg

Heather Panaschuk  
Program developer, Library Consultant, River East School Division, Winnipeg

Don Ewonchuk  
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Sid Greenstone  
Project Leader, Steinbach Regional Secondary School, Chemistry/Biology Teacher, Steinbach Mb.

Bob Lepischak  
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- 1988, Grade 5-9 Provincial Curriculum writer

Please Note: The editor would like to remind our member organizations and individual readers that all articles in Science Education International are available for reprint in your own journals. All copyrights are extended to members. This is a wonderful opportunity. Please consider starting an international section for your journal and use our fine articles to expand global awareness. All we ask is that you give credit to the author and the ICASE Journal.
Science Education Around the World

Member associations and individuals are invited to contribute to this section. Suitable items include brief accounts of specific projects of international significance, science education in a particular country, or international and regional seminars and conferences.

PRIMARY SCIENCE IN FINLAND

Dr. Tuula Asunta
University of Jyväskylä
Jyväskylä, Finland

Introduction

At the moment there are going educational changes occurring at the moment in every level of the Finnish school system especially in the area of Science. These changes are concentrating on rearranging the curricula of the schools as well as changing the methodology of teaching, making Science courses more laboratory and field oriented, producing appropriate books and other teaching materials as well as in teacher training. After the Leikola committee in 1989 which stated several points including that our teaching and learning should be oriented to raise the level of our students internationally, Universities and schools started little by little to change their curricula.

This year our National Board of Education has started a program to improve the quality of mathematics and science teachers of different schools and school levels. The Board of Education has been chosen 25 communes to be so called PILOT-communes in this improving project and at the moment the inservice training of teachers includes 118 schools covering different types of schools (see diagram, Fig. 1) and at all school levels starting from nursery school. All schools in Finland are public (supported by state). Mathematics and Science teachers have also their own organizations or associations which are for teachers from primary schools up to University teachers. These associations that take care of the inservice training of their members by arranging meetings two three times per year and inservice training courses throughout the year all around Finland.

Schools and School Science

Nowadays most children in Finland have an opportunity to attend day nursery school nowadays. There is very little, if any, science instruction in the nursery schools. Many of these nursery schools arrange however so called pre-school for 6 year old children. Usually this type of pre-school lasts for 5 hours per day and includes learning different things—also some science activities in many pre-schools.
The formal primary school covers children from the age of 7 to 12. Science is taught in separated subjects, mainly until now as biology and geography with very little chemistry and physics.

From the ages of 12-15, children attend secondary school (compulsory education) and science is taught in separated subjects such as biology, chemistry, physics, etc. by science teachers, who have had University training for subject teachers and have usually specialized for two or three subjects as for example mathematics and physics, computer science and physics, chemistry and physics, etc. From the age of 15 to 18 years, children attend to high school and science is taught in separated subjects in an advanced level.

Each year children have to reach a certain level in their learning. That level is assessed by using either national tests or more usually the tests made by the teachers, who also decide for the next step. It is very seldom at the primary level that children is not moved up to the next class. The teacher must discuss with the parents if he/she thinks that some child is not capable enough to reach the requirements needed during next class. At secondary level and at high school there are some students every year who are not moved to the next level.

**Primary School**

In a primary school class, the average number of pupils is around 20 to 25. There are two types of primary schools:

1. Primary schools of four grades in two classrooms, where two first grades are in one classroom and grades three and four are in another classroom and fifth and sixth grades in separate classrooms.

2. Primary schools with all six grades in separate classrooms.

There are also some primary schools that only have four grades. Those are called “village schools” and they are usually quite small having from two to four pupils at different grades.

The assessment for primary school pupils is different in different schools:

1. Many schools use only an oral test in first five class and in sixth class a written grade mark from written exams in each of the subjects taught during the school year.

2. Some schools use a written grade in each class.

There are two main terms in a year. Pupils are tested in different ways during school terms. They must have certain ability of basic skills, such as reading, writing and calculating. If a teacher thinks that a pupil is not capable enough to be moved on to the next class in the spring she/he has to discuss with the parents before doing any decision. At the end of the terms parents will receive the record of achievement—either oral or written.

After 6 years schooling children will attend lower secondary school for three years and then they need to choose if they want to go to upper secondary school (called high school) or stay one more year (10th class) at the secondary school or go to vocational and after that attend vocational universities or polytechnic-schools. Vocational university and polytechnic schools are very new in Finland. This level was started three years ago so it is still “looking for its place.”

**The 1994 National Curriculum and Primary Science**

The National Board of Education publishes a guide book to the curriculum for schools. This guide includes the most essential contents of subjects that every school should teach (POPS, 1994). The guide was produced because all schools should teach approximately same basic knowledge to all pupils.

Until 1960 children had more science content in their primary curriculum, but after that for 20 years they had only biology and geography contents with minor exceptions which depended on the interests of the teachers. Now we have finally put science back to the primary curriculum but it will take many years until we get all the teachers trained to teach science contents including chemistry and physics. This belief is based on the fact that science we have not had these subjects included in our teachers training program, most of our primary teachers are not confident to teach other science content but biology and geography. However many primary schools have now integrated science four to six hours per week and they have reserved one hour for chemistry and physics.

We have several new textbooks in primary science that teachers can use, but all of them are still more or less biology oriented. That is why teachers who want to teach more science content, must make their own materials and worksheets mainly relying on the
secondary level textbooks or the material produced by different teachers organizations. The department of Teacher Education have this year included more science training in the program than there was a year before and the amount will be growing every year. Elementary student teachers have now first time in over ten years an opportunity to specialize in chemistry and physics, and no doubt some of them will use this opportunity. One teacher usually acquires expertise in one or two subjects.

For the first time for a long time student teachers will now study a subject called "science and community," that includes integrated chemistry, physics, biology, geography and mathematics.

Environmental education has an important part of students training program. It includes for example the following studies: Introduction to environmental education, Introduction to water pollution, Environmental education in school, Environmental education in practical teaching work, Environmental philosophy and ethics, Finland's water systems, Introduction to water pollution and so on. There are also several integrated courses as for example: Environmental studies and natural history and various integrated themes in primary and early education that students can take if they are interested. Specialization studies in environmental education include the following studies: Theory and methods of environmental education, Environmental philosophy and ethics (seminar), Foundations of environmental protection, Introduction to ecology, Environment and natural history, The constructed environment, Introduction to environmental protection technology, Legislation and administration of environmental protection and General seminars reviewing and synthesizing course contents.

Results on the New National Curriculum and Textbooks

As it seems to be in most countries also our primary teacher is responsible for many different subjects. Because science is now included in the curriculum it has caused some stress for a number of primary teachers. They must include some science in their teaching and that means they have to train themselves. New textbooks include programmed material for learning and teaching methods (student activities, learning targets, didactic actions, evaluation, etc.) although there is still lack of problem solving oriented books. Anyway it will take some while before all schools will have suitable equipment and laboratories for teaching science properly. Those teachers who feel themselves inadequately prepared to teach scientific contents will especially suffer.

Fortunately there are a great many primary teachers who have been teaching some scientific contents all the time and also many teachers who are very enthusiastic to learn and teach science. Our teachers have shown that as long as the teacher has creative imagination and wondering mind he/she will find the way to teach science without any specific equipment or room provision. At the primary level the most important thing is that the teacher allows pupils to wonder at different phenomena and let them think why certain events occur. The good teacher can say to pupils: "I do not know but we will find out."

References


THE "SUCCESS WITH SCIENCE" INSET PROJECT FOR
PRIMARY TEACHERS IN JAMAICA: A DISTANCE LEARNING
INITIATIVE TO PROMOTE SCIENTIFIC AND TECHNOLOGICAL LITERACY

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Much current institutionalised learning takes place in a closed and prescribed format and this occurs in classrooms through face-to-face delivery of courses. Typically classes are held on a regular basis at an agreed location. The pace of teaching and learning is largely defined by the progression of content within the course itself. The learners have to "keep up" with the sessions or risk falling behind and possibly, losing a place within a course.

This pattern however is changing.

Teaching and learning styles are evolving so that they place greater emphasis on accommodating the learning situation of the student. Some of these styles are referred to as "open" and "distance learning" (ODL), and they have certain similarities. They are all essentially quite similar in that some aspect of engagement within these learning patterns may not be conducted in a traditional face-to-face delivery mode, in a formal centre and within "normal" educational working hours.

The term "open learning" (Briggs et al., 1987) has been used to refer to a process which makes;

... learning openly available to learners no matter who they or where or when they wish to study ... while much open learning has used distance-teaching techniques it does not necessarily do so. Open learning can mean, for example, that a college stays open for longer hours, and makes learning materials available to students as well as providing classes and lectures (p. 9).

Distance education (Briggs et al., 1987) is defined as an educational process in which a "... significant proportion of the teaching is conducted by someone removed in space and/or time from the learner" (p. 9).

Within this paper, distance learning is interpreted as a learner-centred perspective within a distance education framework.

A benefit of the adoption of ODL measures for course delivery may be that long and sometimes difficult journeys to a learning centre become unnecessary. Open and distance learning can be supported and delivered by all manner of written materials, videos and support kits. More lately, a whole battery of information technology has started to make giant strides in opening up entitlement to education via ODL.

A few of the differences between ODL and "traditional" teaching and learning modes can be summarised thus:

**Face-to-face learning**

- Is delivered in a centre.
- Students travel to the place of learning.
- Students learn together at the same time.
- Students gain benefit from direct interaction with tutor.
- Course content may be written as course is delivered.

**ODL**

- Can delivered in a centre or off-site.
- Learning is brought to the students.
- Students may learn independently at times of their choice.
- Interaction with tutor may be limited and may be delayed (postal/e-mail).
- May need less direct tutor support but must work in a flexible mode.
- Course content prescribed by learning materials and requires much initial preparation.
- Learners may feel isolated.

Clearly, ODL and traditional face-to-face modes of course delivery do not have all the answers to the
problems of teaching and learning. Each has advantages and disadvantages—and these will be perceived differently as much by students with a range of needs in different learning environments as by course providers with a careful eye to resources and budget controls.

**ODL can be an effective way of delivering in-service education and training (INSET) for serving teachers INSET for primary teachers perhaps has special significance in the fields of science and technology. There is a need to update teacher knowledge of scientific content and teaching methodology can be seen as part of the continuum of entitlement to scientific and technological literacy embodied in Project 2000+ (1993).**

De Jong (1996) describes three fundamental areas which concern the professional development of teachers of science. These areas address the implementation of new curriculum topics or even new curricula, dissatisfaction with existing ways of science teacher training, and the impact of new ideas about teaching and learning science. This last area of concern is the so-called constructivist dimension in which learners actively construct meaning from actual experiences, often from the ashes of challenged past beliefs which are referred to as “misconceptions.”

There has been an explosion of comment and research endeavor in primary science education over recent years. Such activity has explored children’s alternative belief patterns that are seen to be at odds with widely accepted scientific “truths” (Driver et al., 1985; Ollieranhaw & Ritchie, 1993; SPACE, 1990-1992). This has led to new approaches to the science curriculum and the development of innovative teaching strategies and materials (Nuffield-Chelsea Curriculum Trust, 1996). No doubt such changes could be said to have placed new demands on teachers.

Perhaps a response to perceived economic factors, curriculum development in many countries now often embraces design and technology. This too places fresh demands on teachers serving the primary sector.

It is no surprise therefore that in a developing country such as Jamaica, delivery of INSET can pose problems for students and tutors. Teachers in rural areas may be disadvantaged in their quest for continuing professional development by poor communications and difficulty in finding or providing funding for such activity. Many teachers are unable to afford their own transport. Transport by taxi and minibus can be unpredictable. Difficulties in transport, and the need to give careful consideration to the costs of INSET are particularly important in the mountainous north east of Jamaica. Teachers in small rural schools face especial difficulties of isolation.

The parish of Portland is situated in the northeast of the island and it is served by the picturesque regional centre of Port Antonio. On the first day of 1996, just three miles outside Port Antonio a new institution in Jamaica was born. Situated just off the coastal highway in a richly forested setting, two colleges were merged to become the College of Agriculture, Science and Education, or CASE. Through the merger, this institution now has considerable academic capacity. It has degree-awarding powers and is able to combine the fields of agriculture, science and teacher education through college-based teaching programmes and the imaginative development of research and outreach applications.

One area of development which draws upon the full strength of the College is a research and outreach venture to assist primary school teachers in their delivery of the scientific area of the curriculum. INSET through distance learning was clearly seen as a possible strategy to overcome some of the problems of delivering INSET to far-flung rural schools.

Through the office of the Minister for Education, Youth and Culture (MoEYC), a request was made to the Commonwealth of Learning (COL) in order to obtain samples of distance learning materials. These were seen as offering innovative ways of delivering science INSET to teachers of children in the primary years of schooling. COL is a Commonwealth-supported organisation. Briggs et al. (1987) state that the long term aim of COL is directed so that “any learner, anywhere in the Commonwealth shall be able to study any distance-teaching programme available from any bona fide college or university in the Commonwealth” (p. 60).

It was decided that for the purpose of the Jamaican pilot a small number of local schools would be asked to volunteer staff to take part in a trial of the INSET course using just a part of the distance learning materials received from COL. It seemed advisable to start the trial in a small way so that tutors and teachers were not over-burdened with novel experiences. The local trial would involve an introductory day or “welcome workshop” in which participants would have a chance to familiarise themselves both with the content of the learning materials and ways in which distance learning can be carried out.
A strength of the ODL materials from C4 has always been that they have provided a platform of ideas for classroom teaching and at the same time promoted learning by the teacher. Activities from classroom application can be used as a basis for reflection and analysis so that the teacher can probe his or her understanding both of science and of professional issues. Following the welcome workshop it is planned that teachers in the pilot project are to pursue the trial INSET course largely in their own schools, with tutorial advice supplied by visiting staff from CASE.

The trial INSET course will end with a final day-school in which participants will display work undertaken during the course and provide verbal feedback to colleagues. Experience in the UK of this sort of final course experience has suggested that teachers value the professional exchange that can occur when looking at work achieved by children as well as ideas they as teachers may have used as vehicles to motivate their classes.

Of course, as in all applications of distance learning, student isolation can be a major problem. The initial and terminal workshops are thus offered as a way of strengthening relationships both within the pilot course membership and with CASE staff.

However, besides management, there is the question of the content of the materials themselves.

The core of scientific content has not needed to be changed significantly. It is a feature of accepted scientific ideas that their meanings are widely shared; the science is relatively stable. The contexts in which scientific ideas can be presented however, can vary considerably.

It was decided during the second consultancy visit, that editors' workshops would be held so that CASE staff, local teachers, local education officers and representatives from the Ministry of Education Youth and Culture could participate in the process of changing the ODL learning materials to meet the specific needs of teachers in Portland.

It was decided that it was better to invest in quality rather than quantity with the limited time available. Therefore only a few of the original distance learning materials from The Commonwealth of Learning were edited. However, as a result, a sense of "ownership" has grown up with the edited units.

The changes to the original ODL units have been considerable. Essentially "Euro-centric" text has been given a thorough editing to reflect the local environment. For example in the text on "Using the Environment" local place names and features have been used wherever possible. Reference to fruits and wild creatures now reflects the indigenous flora and fauna of the Caribbean.

Some of the activities in the distance learning units were completely out of place in a Jamaican context. At an editing workshop undertaken during a humid 33 degree afternoon at the start of the rainy season, an activity on "keeping warm" was seen as outrageously funny and given savage treatment with the editors red pen!

A further strand which influenced the re-writing of the materials was the Jamaican Curriculum itself. At the primary level this is contained in six grade-related books which specify content and progression Foundations of self-reliance: A curriculum guide for the Primary Stage of education, Grade 1/2/3 (1980a) and Foundations of self-development: A curriculum guide for the primary stage of education, Grade 4/5/6 (1980b) have formed the basis for the curriculum for a considerable number of years. This is soon to change.

The Curriculum Development Unit in Kingston, a division within the MoEYC, is currently undertaking a review of curriculum content. Within this review, there are exciting possibilities for the exchange of information between CASE and MoEYC so that an innovative distance learning INSET scheme and a new curriculum can inform each other.

There is more to the INSET initiative at CASE than just the introduction of distance learning materials for science. Besides materials from COL, CASE has copies of new materials to support teaching and learning in design and technology. These were written by Parkinson and Plimmer (1996) with the support of British Nuclear fuels. These too may play a part in the dialogue between CASE and MoEYC. Design and Technology still has to find a formal place in the Jamaican curriculum.

Further development on the design and technology front towards increasing scientific and technological literacy may come from innovation in the early years of education. Many developed countries have a strong tradition in the use of construction kits to extend manipulative skills and support the interaction of hand and eye to produce something "useful." At a fundamental level this type of activity can be justified on one facet alone—it allows children to develop their imagination, which many would say is at the root of the education process itself.
Imported goods are expensive in Jamaica. Precision made plastic construction kits are beyond the finances of the vast majority of Jamaican schools. Yet within the scope of the INSET project in Jamaica there is a classic opportunity to develop something for the home market which can use local resources and employ local people.

CASE is poised to take up this challenge. The excellent cross-section of skills represented in an institution which has expertise in agriculture—including some mechanical engineering, science and teacher education provides a unique platform for original thinking and development of Caribbean ODL materials.

References

Briggs, R. H. L., et al. (1987). Towards a commonwealth of learning, a proposal to create the University of Commonwealth for co-operation in Distance Education. London: Commonwealth Secretariat.


Useful address:

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Box 10428
Vancouver, British Columbia
CANADA V7Y 1K4
http://www.col.org
email: info@col.org

Please note that COL deals directly with Commonwealth governments. Organisations wishing to secure distance education materials will need to apply through appropriate government channels.
THE TOOLS OF A GOOD TEACHER

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To be a good teacher you must:

1. Be a master of the subject.
2. Have a desire to teach and impart this knowledge to others.
3. Know the methods of teaching, and have the technical ability to do the task.

First and foremost is Knowledge. You have to work hard to become a master of the subject. It is done by reading; reading everything possible, not solely the syllabus outline. Nowadays there is much talk of Process. All Process and no Knowledge is a thought crime.

If you have become a "teacher" because of job security or some other reason other than a Desire to teach, then you will never succeed. You MUST love teaching to be successful.

As for Technique, this is a learnable collection of tricks. Effort can always produce competency; genius is born in the person.

But we are all teaching some aspect of Science—we are all Scientists. It is therefore worthwhile to ask: what are the Attributes of a Scientist?

A scientist must:

1. Be interested in everything.
2. Have a wide vision, be open-minded, able to evaluate radical suggestions objectively and not be blinkered; and be ready to consider unusual options.
3. Have imagination, and see in something what others cannot.
4. Think laterally, and not keep plodding in the same old rut.
5. Be skeptical, and not a blind follower of accepted dogma.
6. Be a collector of data and a classifier of facts; always on the lookout for the unusual.
7. Be a creator, tester and destroyer of theories.

So a teacher of any branch of science must always: be interested in learning more and more; and be able to use this new information to progress. A good teacher always has a built-in junk filter. All the policies and structures in the world are valueless if the teachers are ignorant—if they know no facts. And only they can learn the facts; they must do it for themselves. To master Content, one must use the Process of reading. Everything that we need has been written down—20, 30, 40, 50 years ago. But it takes effort and imagination. Use jokes, anecdotes, Calvin and Hobbes cartoons, songs—everything to show that learning is an enjoyable activity.

It is interesting to compare the attributes of those famous teachers of 50 years ago against our requirements for success as a scientist and teacher (see Five Famous Teachers, 1994).

It takes effort to be a good teacher, to be a master of the subject, to do it right. True teachers and scientists get excited when they make an unexpected discovery or a breakthrough. J.L.B. Smith described the feeling as being "struck by a heavy blow, a white-hot blast, feeling shaky and queer all over; my body tingled." This is the same as the blast of lightening when you fall in love!

George Patton's comment was "God, how I love it!" That is how a teacher of science must feel as he walks into his laboratory—"How I love the smell of chemistry in the morning, I smells of fun" and if it is not fun, quit: get out as fast as possible and find a job elsewhere.

Oh: the "Tools?" Any teacher can figure that out.

Brain: to hold the knowledge
Eyes: to read everything
Ears: to listen for new ideas
Mouth: to discuss with others and tell your pupils
Hands: to write articles, as well as on the chalk board
Feet: to carry you to the library to gain more knowledge

References


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**SCIENCE & SOCIETY: TECHNOLOGICAL TURN**

*International Conference on STS, Japan*

*March 1998*

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Comparing Misconceptions in Physics Between Chinese and American Students

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Introduction

In physics education, for some time science educators have realized that meaningful learning in physics involves the mastery of concepts rather than facts and problem solving using equations (Lightman & Sadler, 1993; McDermott, 1984, 1990, 1993). It is becoming increasingly apparent that success in manipulating equations is not necessarily a reliable measure of conceptual understanding of physics. The most significant indicator of students’ understanding is the grasp of basic concepts.

The focus of this study is to investigate to what degree high school students of the People’s Republic of China and students in the United States differ in their understanding of basic concepts of physics measured by the incidence of certain misconceptions they have after instruction. Specifically, 12th grade student’s misconceptions associated with electric circuits were tested by administering simple circuit problems developed by the Physics Education Group, University of Washington, Seattle, Washington (McDermott & Shaffer, 1992).

Population of the Study

The population in this study consisted of physics students in the United States and the People’s Republic of China. Because of the association of the investigators with specific districts of the two countries, students were selected from Shijiazhuang City, Hebei Providence, People’s Republic of China and from the state of Iowa, United States. Chinese students in grade 11 and American students in grade 12 were selected because electricity was taught during these grade levels.

In China, there are different levels of secondary schools. Key high schools have been developed for the main purpose of preparing students to go to college. A second group, high schools of good reputation, also prepares students for college even though they have not been appointed as key high schools. The third group, ordinary high schools, also prepares students for college, although a minority of their students pass the college entrance examination. The fourth type is the vocational secondary school (from grade 10 to grade 12), whose main purpose is the direct training of the work force. Its curriculum is more flexible, and usually physics is not taught in this type of high school.

At the end of the 9th grade, all of the students are selected into different types of senior high schools based on their scores on entrance examinations administered by the Province Education Commission. Since these students are selected into these school based on their ability and since the motivation of entering college is different in the schools, one often finds dramatic differences in student achievement.

In Shijiazhuang, a provincial city with a population of three million people, there are 48 high schools, of which three are high schools with good reputation, 234 are ordinary high schools and three are vocational high schools. Five schools were chosen among three types of high schools: one key high school, one high school with a good reputation and three ordinary high schools. They were chosen because of the author’s accessibility to them. The sampling of American students involved three high schools in northeast Iowa. There were 238 Chinese eleventh-grade student and 140 twelfth-grade American students that participated in this study.
Procedures

The assessment of students' understanding of electric circuits was conducted by administering simple circuit problems developed by the Physics Education Group, University of Washington. The tests were administered approximately one month after students had completed their study of electricity. The test sheet was translated into Chinese and sent to one of the authors, Miss Xioulan Meng, a faculty member of the Physics Department, Hebei Teachers College, who then contacted secondary school physics teachers and administered the test. Students were asked to compare brightness of light bulbs and give reasons for their answers or show how they arrived at their conclusions. No extra instruction was given to the students such as the ways of using or not using equations to solve these problems. Twenty minutes was allowed for the students to take the test. Students' answer sheets were returned to the University of Northern Iowa, where all answers from American and Chinese students were evaluated.

The data are displayed on the bar graph for each of the levels of Chinese schools; the high schools (Key) the high schools of good reputation (GR) and the ordinary high schools (Ord) for the performance of the student on each of the problems. Also shown on the bar graph is the total score for all Chinese students and United States students in the study.

Table 1

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<tr>
<th>Electric Circuit Problems</th>
<th>Chinese and American Students</th>
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As can be seen in Table 1, the Chinese students, in general, scored higher than the American population on the electric circuit problem one. Fifty-three percent of the 12th grade Chinese students from all five schools answered the first circuit problem correctly. There is considerable variation in scores between the various high schools in this Province of China.

Only 13 percent of the American 12th graders answered the first circuit problem correctly. The most common error by the American students (23 percent of all students) was to say that bulb B was brighter than bulb C. These students showed confusion related to the properties of both current and voltage. Some students said that the voltage is greatest when entering B, not distinguishing between potential and potential difference. The other difficulty was in believing that current and electrons get 'used up' as they travel through resistors.

Another 18 percent of the American students indicated that bulb A would be brighter than bulb D and E. Students believed that if there was only one bulb in the circuit, then that one bulb would receive all the power. They argued that if there were two bulbs in the circuit, such as D and E, then the power would be split between the two bulbs. They fail to demonstrate a basic understanding of the general model for properties of series and parallel branches in a circuit.

Sixteen percent of the American students thought that bulb A and bulb B would have the same brightness. It appeared to them that if there was no resistance between the battery and the first bulb in the circuit, then the bulbs would have the same brightness. American students do not have a good understanding of what factors in the circuit are responsible for determining the brightness of the light bulbs.

For the Chinese students the most common incorrect answer given was D = E > A > B = C. Chinese students used formulas very well in making calculations, but there were times when they did not discern correctly what they had calculated. They said that the power through E was greater than the power through A because they took the current through E to be twice the current through A.

Science Education International, Vol. 8, No. 1 March 1997 17
The Chinese students showed their reasoning through derivations using equations. They started their calculations with the equation \( P = IV \). They used symbols throughout their calculations and never selected numerical values for any of the elements in the circuit.

**Electric Current Problem 2**

In the second problem, shown in Figure 2, students were asked to compare the brightness of bulbs A, B, C, and D with a similar format as in problem one and explain their reasoning. Whether or not students consider the internal resistance of the battery, the brightness of the bulbs would be given as \( A = D > B = C \).

**Figure 2**

Eighty-seven percent of the Chinese students answered this problem correctly. In contrast only 24 percent of American students answered this question correctly.

Forty-five percent of the American students said that \( A > B = C \). Students reasoned that most of the current was “used up” in getting through the first bulb and that very little was left for the fourth bulb, D. Some of the students also used the concept of voltage erroneously, feeling that there is less voltage as the electrons pass through the circuit or that D is toward the negative end of the voltage.

A smaller number of students (7 percent of both American and Chinese) concluded that the voltage was the same across A, B, C, and D. They predicted all four bulbs to have the same brightness. They failed to recognize the effect that resistances in parallel have to the total resistance of the parallel arrangement of bulbs. They also failed to recognize that the current in B and C is half the current in either A or D and its effect on the brightness of the bulbs.

In general, Chinese students did very well on this problem. Some students did not reach the right answer only because of calculating error.

**Electric Circuit Problem 3**

In the third electric circuit problem shown in Figure 3, students were again asked to convey their understanding regarding the circuit by comparing the brightness of the five light bulbs. The most direct comparison can be made by comparing the current through each of the bulbs which yields the comparison that \( E > A = B > C = D \).

**Figure 3**

This problem proved much more difficult for both the Chinese and American students. For the Chinese students, 57 percent answered correctly while only 3 percent of the American students answered correctly. On this problem the kinds of errors made by both the Americans and Chinese were quite similar. The most common incorrect response for Americans (25 percent) and Chinese (18 percent) said \( A = B = E > D = C \). They assumed that the potential difference would be the same across A, B and E and that the voltage across C and D would be half the voltage across E. Some argued that the current through A, B and E would be the same and arrived at the same conclusion. Another 21 percent of the American students and 7 percent of the Chinese students answered \( A = B > E > C = D \). The reasoned that the resistance of A and B was less than the resistance of C, D and E and that the resistance of E was less than the resistance of C and D. They also concluded that the smaller the resistance, the greater the power.

The number of Chinese students answering all three problems correctly varied considerably among the different types of schools in which they were enrolled. Ninety-five percent of the students from the key high school and the high school with good reputation used equations to solve the problem.

**Discussion**

Physics enjoys a much higher level of importance in the Chinese curriculum. Physics is given a central
position in the curriculum ranked lower only than Chinese, mathematics, and English. All students take physics each year starting in the eighth grade and continuing through grade twelve. The Chinese school year is 42 six-day weeks or 252 days. Physics is taught to eighth and ninth grade students approximately 100 periods per year and to tenth through twelfth grade students approximately 140 periods per week for a total of 620 periods of physics. The American student may take a ninth grade physical science course which will be at least one-half physics. With 180 days in the American school year, this translates into 90 periods. Those that take high school physics will add another 180 periods for a total of 270 periods of physics instruction. This exposure is only for the 25 percent of American students taking high school physics. So, clearly, the Chinese students have had a much longer exposure to physics. Usually, Chinese students will have had 35 periods of electricity when they finished high school, whereas American students may have only 15 periods.

In order to attend college, Chinese students must pass the National College Entrance Examinations. Only approximately 15 percent of the students from high school go on to attend college. Also, only about half of the population of eighteen-year-olds are in high school. Society places a high value on students that graduate from college and are rewarded with better job security, higher social status and better benefits. Since physics has the reputation of being difficult, and is a mandatory course for the College Entrance Examination, students spend considerable time studying physics.

There are many variables in making comparisons in outcomes between different cultures. Therefore, it is difficult to import certain practices in hopes of assisting achievement in another setting. In physics education we should, however, be open to observing and analyzing practices by educators in other parts of the world to gain insights into how students think and learning their society. It does appear that when a society identifies a concept or practice as having high value and a commensurate time is spent on attaining excellence in that area that quality results do occur.

References


Note to Member Organizations

Please ask your members to submit material to Science Education International. We are looking for:
• Teaching activities and lessons, especially for elementary
• Action research articles which talk to the practicing teacher
• Research articles which focus on practice, not research strategies
• Informal and nonformal articles which address “Things to do” in these settings

PLEASE INCLUDE PICTURES AND OTHER DRAWINGS OR GRAPHS.

Manuscripts may be sent to:
Ronald J. Bonnstetter, Editor
ICASE Journal
University of Nebraska
211 Henzlik Hall
Lincoln, NE 68588-0355
USA
THE STEPPING INTO SCIENCE PROJECT

Dr. Sue Dale Tunnicliffe
ICASE Primary Projects Officer

This project began in 1988 as an initiative to encourage primary teachers and their children in engaging in 'hands-on' science activities as well as sharing and emphasising the importance of primary science work throughout the science education world. The project highlights opportunities for science with primary children and the importance of early involvement with scientific process and phenomena and is aimed at primary aged school children, in pre school and then the first six years of formal schooling or to whatever age primary (elementary) education is deemed to finish and is open to any group or individual. It is run under the auspices of ICASE, the International Council of Associations for Science Education, who are represented in each country by the National Science Teachers Association. There are associate members too who may be firms or institutions.

The project is targeted at primary schools and involves pupils doing a number of science activities which involve the science process as well as learning new knowledge. After being involved in at least six projects the pupil may be awarded a certificate and be said to have taken a 'Step into Science.' The science task are not prescribed because each country has its own curriculum and ways of presenting science. The Stepping into Science Newsletter, STEPS, sent to all member of ICASE and available to individuals on subscription, carries a number of activities from around the world which can be used and provide an additional international dimension. The activities may be freely copied for use with pupils. A collection of 50 activities is available in the ICASE Primary Science Book which can be purchased through the ASE, College Lane, Hatfield, Herts, AL10 9AA, UK for £12.

Teachers are encouraged to work with their Science Teachers Association to choose relevant and appropriate activities for their pupils.

The STEPS are: YELLOW—pre-school; GREEN—age 6 - Grade 1; BLUE—age 7 - Grade 2; RED—age 8 - Grade 3; ORANGE—age 9 - Grade 4; GRAY—age 10 - Grade 5; PURPLE—aged 11 - Grade 6.

The Step into Science is taken through being involved and not through getting an experiments 'right.' Some schools and out of school groups run a Stepping into Science Club for interested children whilst other teachers make the scheme part of their school science work but award the certificates to encourage their pupils and to introduce an international awareness into their work.

CERTIFICATES

The certificate printed below can be reproduced locally for awarding to children. They may be used as a white certificate with the colour of the step taken written in or a star or other mark made showing the colour of the Step taken. Alternatively they may be printed/photocopied on the appropriate coloured card or paper. Each child can be given one certificate on completing the first step and additional steps can be shown by adding a collared star or other mark to the certificate. One certificate for a child can be obtained from Dr. S. D. Tunnicliffe, Homerton College, Cambridge, CB2 2PH, England or 18 Octavia, Bracknall RG12 7YZ, England.

LOCAL AWARD CEREMONIES

We encourage local Science Education Societies to have a stock of the certificates and distribute them locally and arranging local award ceremonies to highlight pupil’s achievements in science. Local press releases can be written and the Primary project co-ordinator notified so that the children’s success can be featured in the ICASE newsletter.
STEPPING INTO SCIENCE

has successfully taken

A STEP INTO SCIENCE

Date: Place: Step level:

Signed: on behalf of ICASE Stepping into Science project: on behalf of the school:

Sue Dale Tunnicliffe
Dr. Sue Dale Tunnicliffe
ICASE Primary Projects Officer

The Steps into Science are: yellow; green; blue; red; orange; grey; purple.
COST-EFFECTIVE CHEMISTRY: IDEAS FOR HANDS-ON ACTIVITIES

Peter Towse
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Introduction

A two-weeks International Low-cost Instrumentation Conference was held at the University of Wisconsin’s Institute of Chemical Education, Madison, July 15-26. Funded by the National Science Foundation (NSF), it attracted almost 30 participants from the United States and from Egypt, Germany, India, South Africa, Thailand and the United Kingdom.

The goal of the conference, spelled out in the NSF proposal, were:

1. to bring together an international group of scientists, educators, and students who had developed materials to introduce hands-on chemistry at minimal cost and to the broadest range of students,

2. to construct and test the materials with a variety of individuals (including students),

3. to write up these materials for publication and world-wide dissemination to enable teachers, no matter how low their budgets, to introduce or continue hands-on science activities.

Specifically, participants were asked to bring to the conference examples they had developed of:

1. low-cost instrumentation (USD50 or less),
2. low-cost apparatus (USD30 or less),
3. microscale chemistry and low-cost reagents,
4. chemical and biochemical sensors,
5. low-cost microprocessor-based data loggers and instrument controllers (USD200 or less),
6. low-cost computer interfaces (USD15 or less),
7. low-cost desk top publishing.

The case for hands-on experience

Science is a way of discovering our world using empirical, repeatable data to establish theories. As a process, therefore, science is a verb. As data and theories accumulate, and as scientists generate new hypotheses, the body of knowledge tends to be viewed as the whole of science. To many, science has become a noun. The verb science has regularly been attacked by economists as an unnecessary expensive, dispensable part of basic science education. Science educators generally take exception to the claim that science can be effectively taught by treating it only as a noun and not a verb.

In most countries, science education is seen as a necessary support for technological and economic stability and growth. Those involved in scientific and technological discoveries must not only 'know about science,' they must be able to 'do science.' Learning the facts of science may be properly accomplished through textbook instruction. However, attitudes and science process skills cannot be adequately addressed other than in a laboratory setting. Such issues are important to industry, both for the recruitment of young people to science-based careers and the development of the national economy.

International perspectives of hands-on science

A recent World Bank sector review on education (1995) recommends the abolition of laboratory work at the primary and lower secondary levels on the grounds of cost. Science educators find this way of thinking quite untenable. Learning about science and how to do science are two equally important but different functions of science education, and both are necessary.

Project 2000+ set specific goals for greater scientific and technological awareness and understanding, including practical experience relevant to the needs of local and national communities. Similarly, the International Council of Scientific Unions (ICSU) is presently supporting global hands-on experiences at the primary level.

Science education in developing countries should attempt to increase not only to the number of scientists and engineers, but also scientific literacy among policy makers and the general public so that science enhances rather than detracts from social and economic well being. Issues which embrace health, nutrition, environment, agriculture, and industry can only be fully understood through a practical approach. When the basic concepts and practical applications of science are presented to the students in the broader context of the
interaction between science, technology and society, they become much more meaningful, especially to females.

**The pivotal role of teachers**

Many science teachers have little laboratory experience, have never participated in research, and perceive science merely as a collection of facts rather than as a process. So, although laboratory instruction is clearly built into the curricula of most countries, the reality is rather different. There are at least four reasons why teachers are reluctant to engage in hands-on activities:

1. They consider them time-consuming and of largely academic interest only. Laboratory work and the associated instrumentation have little perceived application to everyday life.

2. They are familiar only with the macroscopic procedures and expensive apparatus portrayed in older textbooks.

3. They consider inexpensive alternatives demeaning and confirmation of a second class status. They would rather not use such alternatives, and offer as an easy excuse the fact that they are unable to provide 'the proper apparatus.'

4. Teacher performance is often correlated with student examinations, which do not include practical work.

**Cost-effective laboratory practices**

Chemistry teachers in all countries should use cost-effective laboratory equipment for the following reasons.

1. It reduces the expenditure on more costly equipment, yet will produce the same kind of data. This is extremely important in developing countries where the number of secondary science students is expanding dramatically.

2. It is typically constructed from materials familiar to the student, and so the final product is not foreign or intimidating. The students are better able to transfer what they know about familiar products to the function of scientific equipment. This helps to take the mystery out of chemistry.

Since it is made of simple materials which are often not enclosed in a 'black box,' the students and teachers can see how it functions (especially if they make it themselves). This gives the students a deeper understanding of how it extends their senses and allows them to focus on the underlying concepts rather than on the technology. Only when they understand the basic concepts are the students truly empowered.

4. Students may gain a more realistic view of the historical development of instruments, originally made in a simpler, more straightforward way far removed from the elaborative, expensive 'black box' commercial instruments of today.

5. Only students engage in primary research need expensive commercial equipment. For educational purposes it is most important that the equipment produces reliable data. To be cost-effective does not necessarily mean it has to be of poor quality.

Ware (1992) states the need to redefine the laboratory instruction in the secondary schools of developing countries, but emphasises the need to retrain it in some form. If the gap between the developing and developed countries is to be reduced, the need for hands-on activities in developing countries is even more urgent. These countries need to develop the skilled manpower that will make them fully competitive in a global economy without having to rely on expatriate manpower and assistance.

The introduction of cost-effective science equipment in developing countries is not new. The World Bank has sponsored over a hundred projects which supported secondary school science, but more than half of them were unsuccessful (El Hage, Rinaldi, Ware, & Thulstrup, 1992; Musar, 1993; Ware, 1992). for the following reasons:

1. technical unsuitability of the equipment,
2. educational unsuitability of the equipment,
3. faults in the procurement procedures,
4. high cost of the equipment,
5. lack of teacher and technician training,
6. lack of incentives to use the equipment,
7. faults in the distribution,
8. inadequate supply of consumable materials,
9. inadequate maintenance, repair, and replenishment.

Today, quality equipment may be produced and quality experiments performed at affordable prices. Much of the equipment to be described in the conference proceedings, which will be in the form of a 400-page source book of ideas for hands-on activities, offers at least partial solutions to the above.
The equipment was developed and tested by teachers and students in laboratory work typical of high school chemistry classes. The equipment should only be used if it enhances the existing curriculum; it should not be used simply because it is easy to produce.

The components are inexpensive, readily available in most places, and easy and quick to assemble. Therefore the equipment is also easy to understand and maintain with little or no training, yet it produces reliable data for educational purposes.

Equipment developed at this conference

The equipment represents five price levels:

1. **Minimum or no cost.** A very innovative approach for countries or educational systems without extensive financial support for science teachers or science teacher training is represented by the improvised semi-microscale equipment developed in Egypt. Teachers assemble their own portable semi-micro laboratory kit for work on a desk top at school or on a table at home. The kit can be used for a wide variety of activities and encourages modification of standard experiments. It poses no storage or distribution problems and could easily be introduced in many Third World countries as an important first step towards meaningful hands-on experience in wet chemistry.

2. **Little cost.** A low-cost microscale kit developed in South Africa provides a potentially easier starting point for countries or educational systems, for example in Africa, Asia or Latin America, with only modest financial resources.

3. **Inexpensive.** Well-established educational systems, for example in Asia and Eastern Europe, could benefit from adopting the inexpensive equipment and technical literature produced in India.

4. **Intermediate.** Much of the equipment assembled from commercially available and inexpensive items is appropriate for rural and inner city schools in the United States and some countries of Western Europe. Industrially developed countries can provide the technical support for equipment based on computers, lasers, and other sophisticated by inexpensive items.

5. **Low-cost equipment interfaced with computers or calculators.** Initially, equipment interfaced with computers or calculators may seem expensive, but over the total period of its use it becomes cost-effective. Computer-based equipment for the acquisition and processing of data expedites laboratory experiments and allows a more in-depth study of chemical or biochemical phenomena. For example, a simple, inexpensive photometer can be connected to a LIMSport system to acquire and process data at costs significantly lower than with any commercial system. Similarly, pH electrodes, conductivity cells, chemical sensors and other transducers can be connected. Also in this category is the microwave oven which is widely available, safe and comparatively inexpensive. It allows a large variety of experiments to be conducted in simple beakers and flasks in just minutes.

Empowerment of the teacher

The World Bank study of over a hundred projects, referred to above, clearly demonstrated that providing school laboratories and expensive equipment alone was not enough to guarantee success. This was often the case with projects in Africa. Projects had a much greater chance of success when relevant teacher training was included, as was more common in East Asia.

Such observations make pre- and in-service teacher training the focal point for introducing cost-effective hands-on activities. Such training must be continuously supported through short courses, workshops, newsletters, etc. and through the creation of networks of teachers active in the field.

In many countries, the morale and social status of science teachers is low. Teachers are not well paid and are often forced to hold two or more jobs. This does not create the sort of climate conducive to the introduction of new initiatives. Conditions have to be created which will lead to changes in teaching strategies, including more hands-on activities, the local production of teaching equipment, the efficient repair and maintenance of existing equipment.

Similarly, it is important that laboratory skills form an integral part of examinations (Gardner, 1989). The status of hands-on activities among students and parents would be strengthened and this would lead to improved work ethics in the laboratory throughout the year.

The curriculum should give committed teachers the freedom to include hands-on, project-based components. By combining laboratory activities with those in local science-based industry (agricultural production, manufacturing, etc.), new opportunities for doing science are likely to appear.
At both the local and national level, governments should help to strengthen hands-on teaching by supporting the local production of cost-effective equipment, rather than importing equipment. Imported equipment is often much more expensive than locally-produced equivalents. In addition, the opportunities for repair and maintenance, and the availability of spare parts, are likely to be more effective when the equipment is produced near the school.

An added, and in many Third World countries very important, advantage of locally produced, low-cost equipment is that the fear of using (and possible breaking) equipment would be reduced. Reports of science equipment which was never used (and, in some instances, not even unpacked), because the teacher was afraid to do so, would then become a thing of the past.

References


School Links International in Science and Technology, 1999
ICASE, UNESCO 2000+, ASE

REGIONAL GUIDELINES AND PRELIMINARY TIME LINES

Step 1 June–July 1997
Regionalizing or nationalizing project material, for example possible translation, addition of local reply address, etc.

Step 2 August–September 1997
Copying and distributing the adapted brochure to all members of ICASE in the region and as widely as possible to any other interested people, schools, or education offices.

Step 3 September 1997–Early 1998
Encouraging and collecting as many names and addresses as possible of schools wishing to take part in the links scheme. Making a regional list or data base of the schools interested in joining the international science links scheme.

Step 4 Early 1998
Send to all interested parties or schools in your region who request links a Key Information Sheet and reply letter.

Step 5 April–June 1998
The ICASE Regional lists of those wishing to participate need to be centralized, matched and the links made. Executive Secretary, Jack Holbrook has offered to do this amalgamating of the lists and data bases.

Step 6 Any time after the link is made
Schools and links will forge ahead.

Step 7 Towards the end of 1999
Information from linked groups wishing to share their international Links Science/Technology Project would need to be collected, certificates issued, and the possible means of sharing the experiences carried out (for example possible exhibitions, news letters, posters, booklets).
SCIENCE TEACHERS AS CURRICULUM DEVELOPERS
OF SCIENCE AND TECHNOLOGY FOR ALL

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Introduction

Development of learning and curricular materials by teachers is recognized nowadays as an important and effective method of professional development of teachers (Ben-Peretz, 1990). There is a growing body of information that shows that the imposition of a curriculum by centralized (external) professional bodies in what is called “top-down” fashion, whereby teachers are expected to execute and realize the developers’ philosophy, ideas and intentions, has proved an ineffective way of introducing educational and curricular innovations into schools (see also Eden, 1979; Subar, Silberstein & Shafiriri, 1982). There is an existing recognition for the need and importance of accompanying the work conducted by professional curriculum centers (i.e., The Israeli Science Teaching Center) with materials development activities conducted by school teachers (Connelly & Ben-Peretz, 1980; Sabar & Shafiriri, 1982). Ben-Peretz (1990) claimed that “teachers may function as creators of their own curricula whether through involvement in the process called “teachers based curriculum development” or as “participants in centralized curriculum efforts.”

Several projects conducted in the past (e.g., Ben-Peretz, 1980; Campbell et al., 1994; Sabar & Shafiriri, 1982) involved groups of teachers in the actual process of curriculum development. In such workshops teams of teachers engaged in curriculum development and operated as writing teams. Sabar and Shafiriri (1982) claimed that “participation of teachers in curriculum development is likely to take the teacher from a conscious phase to one greater autonomy and internalization” (p. 310). It is also suggested that teacher based approaches to curriculum development may yield a vast amount of pedagogical ideas and innovative approaches to the curriculum planned.

Science and Technology for All

In the 80’s and 90’s Science and Technology for All emerged as a slogan that embodied a new challenge for science educators. There is a growing feeling around the world that science should be an integral component of education for everybody in school and not only for those who are going to embark on scientific careers. Science and technology should be part of the education of those who will eventually become “future citizens.”

Project synthesis in the U.S. (Harms & Yager, 1981) considered four goal clusters for learning science:

1. Science for personal need
2. Societal issues
3. Career awareness
4. Academic preparation

In order to attain to these goals, in recent years there is a movement around the world to develop and teach science content in the authentic context of its technological and social milieu. Thus, S.T.S. is an effort to produce an informed citizenry capable of making crucial decisions about current problems and issues and taking personal actions as a result of these decisions. It is fairly clear (Hofstein et al., 1988) that the traditional training of teachers both at the pre-service and in-service stages of their development, rarely touches upon the teaching of an S.T.S. based course. In the IOSTE conference in Kiel (Hofstein et al., 1988) the following problems were identified regarding implementation of S.T.S. programs:
• The interdisciplinary nature of the content and unfamiliarity of the teachers with subject matter in which they were not trained.

• Unfamiliarity of teachers with required teaching strategies.

• Inappropriate training techniques and procedures for pre- and in-service teacher training.

The Workshop

The purpose of the workshop described was to involve teachers in curriculum development as part of their professional development and thus to increase their motivation to teach using learning materials that are interdisciplinary and S.T.S. in nature. Such involvement was also expected to reduce their anxiety to introduce unfamiliar subject matter to their classrooms. The workshop was planned as a part of a large scale project in the northern region of the country. This project aimed at enhancing and improving science and technology teaching and learning. The 22 teachers who volunteered to participate in this three year workshop came from different scientific backgrounds (i.e., chemistry, biology, agriculture, nutrition technology and physics) and expressed their interest in curriculum development. These teachers met once a week for about six hours. This time was recognized as part of their teaching load.

The project has three phases:

1. In 1994-95 teachers were involved in collecting and writing learning materials.

2. In 1995-96 a trial version of each of the modules was piloted in schools. Feedback obtained by teachers and observers was used for improving the material and for preparing the next version of curricular materials.

3. In 1996-97 the project's focus is on training more teachers for implementing the modules in more schools.

The teachers were grouped in five groups, each being involved in the development of one of the following learning modules:

• Radioactivity
• Plastics
• Light and Color
• Chemical and biological extermination
• Food and nutrition

Each group has a pedagogical tutor and a scientific consultant. These modules will eventually be an integral part of a new syllabus designed for what is fondly called "science for all." It is suggested that this curriculum will consist of a collection of interdisciplinary (S.T.S) type modules, and the five modules described above are a sample of it.

During the first phase teachers were involved in:

• development of relevant learning material aimed at tailoring the content for non-science oriented students.

• varying classroom procedures in order to increase the effectiveness of the learning effort and students' motivation (Hofstein & Kempa, 1985).

The following instructional techniques were developed for use in the various modules:

• Students small group (cooperative) investigations
• Simulation game and role playing
• Field trips
• Critical reading of scientific articles in newspapers.
• Small scale students' projects
• Structured work sheets.
• Analogies and models.

During the second phase, the modules were tried out in six classes which were defined as "non science oriented," in the following manner:

1) In the first semester, each teacher taught the module which he helped to develop. In the second semester the same teacher taught one of the other modules, developed by his colleagues in one of the other groups.

2) Each teacher, while teaching the module, was accompanied by a peer teacher from his group. The peer teacher took part in all aspects of teaching: lesson planning, preparation and administration of work sheets, tests and additional learning materials.

3) The pedagogical tutors attended some of the lessons, and helped the teachers and their peers.

We are now in the midst of the third phase, in which the teachers are improving and completing the learning materials while teaching them in their classes, and some of them are guiding other teachers in the region with their first experience teaching these modules. Efforts for expanding the program to more schools are made on two levels:
a) introducing the program to more school principals and trying to convince them to adopt it for the appropriate classes,

b) organizing in-service summer courses for science teachers and offering them on going guidance during the school year.

**Evaluation**

The evaluation of the project addressed two main questions:

- In what ways does teachers’ involvement in curriculum development affect their instruction and their attitudes toward teaching and learning? (i.e., on their ability to teach interdisciplinary units, on their self concept as teachers and their understanding of students’ learning difficulties)

- To what extent are the modules suitable for the target population namely “non science oriented” students? (level of interest, relevance, difficulty, prior knowledge of basic concepts etc.)

In order to answer these questions data were collected from teachers and students using a variety of research instruments such as questionnaires, interviews and observations.

The initial results described here are based on data from teacher questionnaires and interviews. Further analysis of the data collected from both participating teachers and students will be completed in the near future. Based on their experience, all participants felt that teachers involvement in curriculum development is very important. They perceived it to be another method to express and utilize their teaching experience and their profound acquaintance with the class milieu, which most of the subject matter experts, when writing learning materials, don’t have.

Most of the participants mentioned that being part of a group was very meaningful for them. They felt that cooperation with colleagues invokes one’s creativity and helps in varying his/her instructional strategies in the classroom. The fact that every group was interdisciplinary in nature with respect to the teachers academic background, made teachers feel that they had a unique impact on the work done on one hand and they learnt a lot from their peers’ experience in other fields, on the other hand.

Few teachers reported that during their participation in the project they gradually incorporated new teaching strategies into their regular classes. They mentioned independent learning of students, or working on projects (individually or in small groups). Three teachers pointed out the fact that their perception of the teacher’s role in class had changed. As one of them said: “Now I don’t teach anymore, I am a guide. As a teacher you don’t have to know everything, you are not supposed to lecture, but to offer the directions and the tools.”

As mentioned above, each group had a scientific consultant. The level of their involvement varied among the different groups. Some of them were part of the whole process of the module’s writing, while others were consulted at the initial stages of planning and helped in defining the main topics and at a later stage were asked to assess the first written version. Tutors felt that the consultants were always available for them and played a very important role, especially in assuring the scientific integrity of the learning materials.

As mentioned above, during the second year of the project a trial version of the written material was implemented in six classes. Each unit was tried out in at least one class. The teachers of these classes and their peers that accompanied them at least in part of the lessons, were interviewed and asked about this experience. The following were teachers reactions regarding the teaching experience:

- The five units which were developed are different in a few aspects: level of difficulty of the materials, the degree of interdisciplinary and the degree of relevance concerning the students interests.

- Coping with the written materials in class gave the teachers an immediate feedback which was used to make proper changes in the next version. The experience in class also affected immediately the forthcoming lessons. Teachers reported that they often felt a need to simplify the materials that were prepared beforehand or to add some materials concerning basic concepts etc.

- Most of the teachers mentioned that since their background is either biology or chemistry, they usually teach high ability students. In this project they had the chance to work with less able students. They were surprised to find out that most of these students showed interest in the scientific topics and were able to participate in the activities held in class.

- It is worthwhile to mention that with regard to two or three classes some problems were
mentioned by the teachers, namely: low motivation to study and lack of learning habits by part of the students, lack of interest in the subject presented or refusal to prepare homework.

Conclusions

We are entering an era in which teachers who were originally trained to teach a certain subject with its unique structure of discipline will have to break the boundaries and teach also topics from other disciplines. Based on the experience gathered in this study, it is fairly clear that one of the methods to reduce teachers anxiety to teach subject matter in which they were not trained is to involve them in both planning and development of the curriculum material. This is in fact a call to train teacher teams in schools with teachers from various disciplines (chemistry, biology and physics) to teach modules and units that are interdisciplinary in nature. It is anticipated that the syllabus in science and technology for all will be flexible and will provide schools with freedom regarding the content. The process of writing learning materials with teachers is tedious and time consuming. However, although the materials produced, need more work in terms of professional scientific editing there is no doubt that this method should not be overlooked as one of the more meaningful ways of in-service teacher education.

References


Cybercheck

This is a new journal for senior students and teachers. The emphasis is on science and society and, as such, is complementary to the ICASE/UNESCO initiative Project 2000+, scientific and technological literacy for all.

The journal will be published bi-monthly in printed form, but will be available also on 3.5 inch diskettes and through e-mail. Annual subscription is 50 pounds for the printed version, 60 pounds for electronic version. The first issue of the Journal has 40 pages.

A specimen copy of the new Journal has already been distributed to all members of ICASE.

Individual subscribers to the ICASE Journal may obtain a sample copy by contacting the editorial office at Viale Agugliari 12, 21100 Varese, Italy (Fax: 39 332 236 997; E-mail: 100707.3432@compuserve.com)
CONSTRUCTING PAKISTAN’S SCIENCE TEST ITEM BANK

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Presently in Pakistan there is a nationwide effort to reform the teaching of science to students and to alter the training science teachers receive. One aspect of the reform involves considering measurement issues that will allow movement toward the development of a mechanism which will enable the achievement of students to be accurately compared and tracked over time. These issues are of use to all countries that are interested in not only reforming science education, but also monitoring progress of teachers and students. In general, the procedures that have been applied to the Pakistani item bank should be an invaluable tool for other developing countries wishing to create and maintain their own science test item banks.

Rationale for a Multiple-Choice Test Item Bank

There have been limited mechanisms by which the science learning of students throughout Pakistan could be quantified. Typical testing procedures usually consist of classroom teachers presenting students with teacher-constructed tests. Furthermore, the vast majority of exams currently presented to Pakistani students do not require higher-order thinking skills, even though the exams are non-multiple choice. Because of this type of problem with teacher-constructed exams, Pakistan’s interest in the use of multiple-choice test items—calling for a range of thinking skills—is an improvement over the present system used to test students in science. Certainly the weaknesses of multiple-choice tests have been discussed in the literature, however Pakistan cannot presently afford the financial encumbrances necessary to develop and evaluate authentic assessment tasks. Pakistan ultimately may be able to move first toward some authentic assessments that use multiple-choice items and then proceed toward the creation of nationwide open-ended exams. But for the present multiple-choice testing, making use of well-conceived items, is the most time-and cost-effective method to follow.

Initial Development of the Science Test Item Bank

Test items for a variety of science topics were developed through a number of steps. First, items were drafted by a team of science educators within IPSET (Institute for the Promotion of Science Education and Training). Second, items were critiqued by a group of the nation’s master science teachers. Third, comments supplied by master teachers were used to further refine test items. Following this process, groups of students who had studied the revised science curriculum were evaluated with the revised test items. During this trial of the science test items, observers sitting in classrooms took note of comments regarding item wording and format that were posed by students to test proctors. Following this administration of the test items, the student comments were used to improve once again the science test items.

Improving, Evaluating, and Utilizing the Science Test Item Bank

To test methods and procedures which might be extended to Pakistan’s entire science test item bank, a subset of the item bank developed for the new curriculum was evaluated. IPSET specifically requested that all 23 test items for the Grade 6 water chapter be evaluated in terms of suitability for making a fair comparison of student performance in four provinces.
To conduct the trial of the test item bank, the revised water items were administered at one randomly selected school in each of Pakistan's four provinces. This division by province was carried out because a comparison of achievement of students in geographically distant regions within the country is one evaluation that needs to be made in order to assess the effects of the reform effort throughout the country.

Analysis of Students' Responses to Science Test Items

Item Response Theory (IRT) was utilized to begin evaluating the appropriateness of using these particular test items to compare students in the four geographically distant provinces. This specific psychometric technique is useful and helpful for a number of reasons. For instance comparisons of Pakistani students can be made when test takers complete a few common items. For example, students of Province 1 could take items 1 through 12 of the water test, while students of Province 2 could complete items 9 through 20. When students complete some common items, often they can still be accurately compared.

Another advantage of using this evaluation technique is that respondents need not answer every item they are administered; test items can be skipped by individuals and a student's ability level can still be computed. Finally, statistics supplied from this analysis help illuminate items which might cause students to answer in an idiosyncratic manner (e.g., highly able students unexpectedly missing an item). Such items may have been poorly written or they might indicate some changes or necessary clarifications in the student text, workbooks, or teacher's guides. Being able to detect items which may have some structural flaw is especially important, for Pakistan hopes to continue its efforts in developing and improving home grown test items.

Results

One aspect of the data analysis was a comparison of the operation of the test item bank as a function of province. More specifically, an investigation was made of test items whose difficulty and/or difficulty ordering is statistically different from one province to another. Analysis indicated that some items functioned in a different way from province to province, but in general the majority of the items seemed to work well for the students.

Another technique used to evaluate this test item bank, involved an analysis of the preconceptions of those who developed the item bank. If test designers really understand the topic and the students being measured, then an accurate prediction of the relative ordering of items by difficulty should be made rather easily. Furthermore, accurate predictions should be possible as to whether or not particular items might cause unexpected responses on the part of students. For example, should any easy items be unexpectedly missed by well performing students? Should any difficult items be unexpectedly answered correctly by students who did not perform well on the majority of test items? By predicting the difficulty ordering of test items, and hypothesizing which items may cause idiosyncratic responses, the appropriateness of this science test item bank can be evaluated in another manner. In order to evaluate the items in this fashion, those who had been involved in the creation of the test item bank (i.e., the second author and others) provided a predicted difficulty ranking of the 15 items which functioned well in all of the provinces. Of these 15 core items, two items did not match the test developers' predictions. One item was predicted to be relatively difficult by the science test developers, but this item was easy for almost all of the students—regardless of province. One possibility for this discrepancy in predicted and actual difficulty may be that the revised text and hands-on activities pertaining to this topic do a very good job of explaining the concept (water vapor) stressed in this item. Another possibility is that the distractors created by the science test item developers did not function as well as in the other items. One item was predicted to be very difficult by reviewers. This was because the item topic (water pressure) was not discussed in detail with students. Nevertheless, the item was answered in a manner by students that suggested it was neither the most difficult nor the easiest test item. Students were apparently able to reason out the answer. Carrying out this step is important for subsequent revision of science test items and as a way of encouraging test item writers to reflect upon the curriculum.

Conclusion

The goal of constructing a single test item bank for a developing country such as Pakistan is a major achievement. Although the demands placed upon the entire science test item bank will be great, item response theory seems to provide a viable technique of easily developing, refining, and monitoring a science test item banks for countries that wish to move toward expanded assessments.

This discussion has presented a number of steps which have been taken to guide the development of a national science test item bank in Pakistan. By following these analytical steps, the Ministry of
Education has begun to build science assessments so that student achievement can be gauged throughout the country and the success of a new science curriculum evaluated. Certainly a larger number of students within each province needs to be evaluated and steps taken to further consider the science items which are to be used for other topics and grade levels. The results of this study suggest that if student measures for particular provinces are to be calculated, then not all of the science test items will be of use initially. In general, those involved in the development of the science test items seem to be able to predict accurately the relative difficulty of test items. Furthermore, the test items evaluated in this study do not seem to have structural deficiencies which caused idiosyncratic behavior. Thus, the test items which have already been developed for this and other text chapters will probably provide a good initial bank of test items.

June 21-24, 1997

International History, Philosophy and Science Teaching Group
North and South America Regional Conference
Calgary, Canada

A regional conference of the International History, Philosophy and Science Teaching Group will be held in June 21-24, 1997 at the University of Calgary, Calgary, Canada. The Dean of the Faculty of Education, Professor Ian Winchester, will be the conference chair. Although a regional conference, all members of the International Group, and others, are welcome to attend. Calgary is situated at the foot of the Canadian Rockies, near to the mountain resort of Banff. The conference programme will include an optional visit to the Rockies.

International and national groups that have interests in the role of HPS in science, mathematics and history teaching are encouraged to use the conference as an occasion to present their work and to consolidate networks.

Proposals for contributed papers, workshops, discussion groups, and exhibits of curricular and instructional materials related to the purposes of the conference are now being accepted. Four copies of the proposal or paper should be sent to Ms. Linda Lenz at the address below. The proposals should include:

1. A cover page with paper title, authors name(s), institutional affiliation, address, telephone numbers, FAX number, and e-mail address.
2. A 100-150 word abstract of each proposed paper or session.
3. Three self-addressed envelopes.

Due date for receipt of papers and other proposals is February 15, 1997.

Format:
Papers should follow the format, style and referencing conventions used in the groups journal Science & Education. Please pay particular attention to form of title, authors name and address, an Abstract of 100-150 words, referencing conventions. Disc submission is necessary. WordPerfect or Microsoft Word for PC or Mac platforms is preferred, but ASCII is acceptable.

Final papers should not exceed 5,000 words. They must be submitted by February 15, 1997. Early submission of proposals and final papers is encouraged in order to facilitate programming and production of Conference Proceedings.

Journal Participation:
It is anticipated that some scholarly journals Interchange and/or Science & Education will publish special issues related to the conference. To be considered for these issues, papers need to be forwarded by October 31, 1996

Proposals and papers should be sent to, and registration information can be obtained from:
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Calgary, Alberta
Canada, T2N 1N4
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Abstract

Creating interest is a fundamental goal of elementary science. Teachers share with designers of science museum exhibits a desire to craft environments which promote and sustain interest. In both settings, formal and informal, control over interaction, direct experience, social use of language, links to prior knowledge, degrees of anomaly, and the conception of the self as a learner influence the creation of interest. In the formal setting, there are clearly defined expectations for learning. In the informal one, multiple possibilities are more common. In both, choices made by learners matter and consideration must be given to the child’s search for understanding and meaning. By studying the museum environment, teachers can learn practices that succeed in fostering interest and in tempering the role of the teacher as an authoritative source of knowledge.

Introduction

Interest is curiosity about experience sustained over time. It begins with playfulness, works through puzzlement, and depends upon ample opportunities for exploration. Interest seeks to experience the unexpected, thrives on astonishment, and turns each new insight into several more questions, questions which “tell” of something understood in asking about something still to learn. Interest looks for the novel in the familiar and how to grasp the unfamiliar in terms already understood. Interest—anchored in personal experience—must prevail for truly meaningful learning to occur. Interest is basic to learning science. Interest finds expression in questions and responds to an answer with another question. By examining the work of “interest experts”—the people who design exploratory exhibits for science museums—we shall discover many lessons about creating interest.

Asking good questions and meaningful learning

Museum exhibits pose questions and tell answers simultaneously. What good exhibits demonstrate is that “telling” is an essential characteristic of questions. This phenomenon of raising telling questions accompanies the best interactive, science exhibits. Science is a way of doing as much as a way of knowing. Good exhibit design invites participation—it provides a chance to do something that connects answers to the authority of how the natural world responds to our questions. At exhibits, someone usually assumes the role of “expert” and begins to tell answers. The best exhibits acknowledge this social role and help the person behaving like a teacher to ask good questions.

A simple transformation of “telling” can suggest much about the nature of a good question. That transformation is to think of “telling” as being an essential characteristic of questions. Instead of thinking about “telling answers” in science, try to imagine “telling questions” (Gowin, 1981). Notice the shift in the sense of the meaning of “telling” from something you do (tell the answer) to a properly of the question (it “tells” us something while asking at the same time). There is no recipe for how to ask “telling questions,” but when it happens, you’ll know by the interest such questions provoke and the number of questions which follow. “Telling questions” ignite interest and interest sparks telling questions.

In summary, “telling” and “praising” go hand in hand with belief in the educational efficacy of “right answers,” placing in jeopardy the basic goal of creating interest in science. Yet telling has its place and knowing some answers is absolutely necessary. How, then, are these points and the jeopardy they entail reconciled with creating interest?
In words, this reconciliation is straightforward. In practice, it is extremely elusive. It begins by acknowledging that “meaningful learning” (Novak & Gowin, 1984) is possible only when a connection is made between a good question and its appropriate answer. Meaningful learning shifts the focus from answers to the connecting of questions to answers. Concern for these connections is synonymous with having an interest. And, as previously noted, the experts on creating interest are those who design exploratory exhibits in science museums. In these settings, interest is the arbiter of successful design. Of course, science museums entice visitors with entertainment and recreation. But the exhibit designers care ultimately about using such an atmosphere to create interest (otherwise they would seek employment at amusement parks).

**Design criteria from “interest experts”**

Traditionally, classroom teachers look to informal science environments (zoos and museums, for example) only for advice in planning school visits or for special materials prepared to supplement school curriculum. Often, the informal institution has a value message to share with the public—protection of endangered species, for example—and schools provide one pathway of communication. Although by definition informal environments eschew formal evaluation of learning while the very structure of schools depends upon commitment to formal assessments, the individuals who attend and learn are common to both worlds. Rarely do representatives of formal and informal perspectives deliberately study the nature of learning common to both settings with the goal of enhancing basic student understanding and habits of learning (cf., Ault & Herrick, 1991; Nagel, Ault, & Rice, 1996).

Common to both worlds is a fundamental desire in creating interest in science. The design of informal environments suggests principles for innovating in the classroom (Ault, Cohen, Kesling, & Vanausdall, 1987). Designers struggle to attract interest, appeal to the senses, promote imaginative play, respond to diverse social groupings, engage prior knowledge, and enhance visitor control over interaction with the exhibit.

The phrase which best captures the intent of informal environments is “learning from experience.” In attempting to create interest, museums, zoos, and field stations capitalize on ideal conditions for learning from experience. What learning from experience actually means, however, is not so simple. Immersion in experience does not cause learning. Consider: “Fish are the last to see the water.” Jerome Bruner has referred to this French proverb to introduce the ambitious (and ultimately controversial) social and natural sciences curriculum project of the 1960s, “Man: A Course of Study” (Bruner, 1965; Education Development Center, 1968). As metaphor, the proverb reminds us of the very basic level of naivety risked by a overly zealous commitment to “learning from experience.”

What does the proverb mean? In some sense, fish do have an “understanding” of water—they behave in ways which respond appropriately to the fluid properties of water. We might say they have learned from experience how to swim, right down to placing this understanding in their biological machinery itself.

Clearly, the proverb is a metaphor about people and culture, not a literal claim about fish and water. Bruner’s choice of proverb underscores how little experience may contribute to understanding without deliberate effort to reflect upon the regularities of experience. Informal environments predicate an essential role for experience; formal ones make deliberate reflection the primary concern, using numerous demonstrations, simulations, or prose creations as surrogates for experience.

What have those who craft each environment to learn from each other about the nature of learning? Rarely do representatives of formal and informal perspectives deliberately study the nature of learning common to both settings with the goal of enhancing basic student understanding and habits of learning. They ought to do so. Consideration of the role of experience—and the limitations of experience captured in the French proverb—is a good starting point. How exhibit design creates interest out of experience has important implications for classroom teachers.

Interest, of course, is not the only goal for learning in science. However, in its absence the others count for very little. Thus, teaching to promote interest is a professional skill of critical value. The common interest in interest in both formal and informal environments unites educators. What works to create interest works for children because of their human nature as curious learners. These children are the same learners responding to the same interest provoking features of their environment wherever that environment happens to be.

**Four concepts about ideal learning environments**

In creating interest out of experience, museum exhibit designers craft environments according to a variety of principles implicit to good design in both
formal and informal settings. Throughout the application of such principles, four concepts play key roles: (1) choice, (2) language, (3) disposition, and (4) anomaly. Taken together, these four concepts provide educators with a basis for designing environments that create interest consistent with principles of an exploratory exhibit design.

1. **"Choice" in formal and informal learning.**

   Formal learning is based upon careful evaluation of achievement and performance, as guided by socially agreed upon purposes for schooling. Informal learning is based upon the exercise of free choice by learners for their own, intrinsic purposes, free of assessment and evaluation by others.

   This distinction characterizes two different contexts for learning; not what happens when learning occurs. In either context, teachers or exhibit designers do not cause learning; learners do. Learners choose to pay attention, choose to consider what experience and information might mean, and choose whether to alter behavior or reorganize their thoughts according to new understandings. Teachers and designers have control over conditions influencing learner dispositions to do so and over the quality of the resources available to them for use in learning.

   In short, both contexts may exert influence over "choice." Informal settings maximize the learner's control over choice of experiences and the choice to learn; formal ones attempt to control the choice to learn with incentives while restricting choice over what to learn. The resolution to this tension appears to be in answer to questions such as, "Who is making the choices and on what grounds? What are the consequences of learning according to free choice for the public and the individual? What are the consequences of attempts to control choice without the consent of the learner?" In either case, experience appears equally necessary—but the control over choice influences attention given the experience by the learner. In both environments, understanding the role of choice is paramount.

   In informal settings, learners have control over the choices they make. This kind of control, necessary for creating interest, presents a dilemma for formal settings where "schools" choose what students ought to learn. When the teacher's goal is to create interest, this dilemma diminishes, for the teacher has simply to adopt principles guiding informal learning as the means to achieve a basic goal in formal science teaching. Both environments often emphasize experience equally. Direct experience is not at issue in contrasting formal and informal settings. Choice is.

2. **Expert jargon and natural language.**

   Consider for a moment this quotation from a third grade girl commenting on her saucer left to dry on a windowsill over the weekend: "The water evaporated and left a solid solution." The teacher wrote on the blackboard, "The water evaporated. What had been communicated?

   The message from the teacher was that the answer was partially correct—the student had achieved agreement with one aspect of correct usage of the term "evaporated." The water was gone and evaporation seemed the most likely explanation. However, the lessons the previous week had built upon an operational definition of solution: a transparent liquid consisting of two or more substances. This objective assumed the role of a "canon of jargon," the goal of instruction being to achieve agreement with this canon in terms of speaking science properly. The teacher sought evidence of agreement in the use of language and found this agreement for "evaporation." She used from her adult, authoritative position a subtle form of social disapproval—failing to write the entire utterance on the board—to extinguish the notion of a "solid solution." "Solid solution" was not a legitimate thought.

   As the discussion continued, the class clearly began to disagree on whether the white powder on their saucers contained water. They agreed that it was dry, but some noticed a curved surface within a crystal shape that might be a drop of water trapped in the crystal. Others used the word "cloudy" to describe parts of the white substance in their saucers.

   The lesson objective, however, was to show how the physical process of evaporation (a phase change of water) had isolated the dissolved substance, table salt, preserving all of its original chemical properties. The teacher guided the class to conclude that no water was present in order to prove that a solution, according to the operational definition of transparency and multiple substances, no longer existed. As an authority figure, the teacher awarded status and imposed sanctions in order to bring classroom thinking into conformity with an objective predetermined by the curriculum. The objective became correct use of scientific jargon.

   The child's notion or meaning for "solid solution" was not explored. Was this phrase reasonable? An example of creative thinking? Did it have potential to encourage thoughtful exchange among students? Yes, indeed. However, it was, in a small way, punished. Furthermore, the basis in experience for arguing for and against the presence of water was suppressed. No encouragement (or time) was spent on considering whether something other than evaporation may have
happened to the water. The lesson, in effect, “abused” children’s thinking by denying them the legitimacy of their own language and in so doing hindered their access to direct experience of phenomenon. Needless to say, as the lesson progressed, fewer and fewer children chose to speak. The goal was apparent: play a language game of achieving socially approved usage; do not worry about making sense of your own experience with and interpretations of a natural phenomenon.

This judgement is harsh, for, in fact, this teacher admirably devoted five days of third grade science lessons to experiential, experimental study. And she behaved in the manner advocated by the commercially published teacher’s guide. Still, this case underscores a common problem in formal learning environments. The formal situation fosters anxiety over being “wrong,” both from the view of the teacher and the students. The focus on the operational definition for solution and the push for correct conclusions were necessary from the teacher’s point of view to prove that the children had learned what was correct (and, presumably, important). The children in short time mirrored their teacher’s anxiety over being “correct” as well as her desire to gather evidence that they possessed the correct understanding of solution (as inferred from allowed or proper usage of language).

This anxiety does not allow the choice of being wrong, defined as failure to conform with sanctioned usage of “solution.” Experience of cloudy crystals and curved crystal walls derailed the process of making “proper” inferences about solutions consistent with the criteria of transparency and multiple substances. More importantly, any attention to the notion of “solid solution,” or response to the temptation to digress in considering disparate observations of cloudiness and curved walls confuses the task of formal assessment. Emphasis on language conformity, on the other hand, enormously simplifies the task of formal assessment. As a direct consequence, children are compelled to ignore their own experience when, in their minds, it fails to conform to imposed expectations. Furthermore, if they are socialized to please authority, they begin to pay little attention to experiences not associated with rewards, and hence, abandon their own struggle to find language which can express and order their own experiences of events. It is precisely this problem that informal environments have the potential to solve.

3. **Skills and dispositions.** Training in skills to a high level of performance follows from commitment to the need for public certification of competence, a key function of formal environments. Informal environments, by definition, do not certify levels of competence. Yet the lack of that need does not mean that learners will automatically succeed in free choice, socially complex, experiential settings. Learning in formal settings and randomly learning from often indifferent, chaotic settings (for example, commercials) do nothing to ingrained an image of the self as a learner. Ideal experiential learning teaches about learning itself. Learning from experience depends upon the individual’s conception of “self as a learner” in terms of confidence, habits, and dispositions.

Nothing is more critical to elementary education than enhancing the child’s conception of self as a learner, and creating interest goes hand in hand with this goal. A good learner knows what interests him or her and seeks new interests as well. The formal classroom—in the context of treating interest in science as a primary goal—has the opportunity to model the habits and dispositions needed by successful learners. In fact, the measure of formal education is how well it prepares children to learn from informal settings—to become, in effect, independent, lifelong learners.

Consider just how powerful is the image of the self as a learner. When something new and unexplainable is observed, people may react with “That’s fantastic!” or “What’s wrong with me that I don’t understand?” The event itself causes neither response; it is the interaction of the learner’s sense of self as a learner with the experience.

This sense of self includes awareness of prior knowledge and the disposition to use it. Good design reinforces this disposition. For example, several visitors to a “colored shadows” exhibit remarked that the colored shadows worked “like rainbows.” Nowhere had the designers acknowledged that prior experience with rainbows might influence how visitors interpreted the phenomena of colored shadows, nor had they anticipated the variety of misuses visitors would use to account for the source of colors (yellow “from my shirt,” white “from a light above or one hidden underneath somewhere”). The designers installed a series of modifications intended to improve visitor grasp of the principle of color mixing to form white light. As a result, visitors stayed longer and interacted more. The most important conclusion was that both learning and teaching improved. When, for example, labels were designed with the function of parent reading to a child in mind, they were used more frequently and tended to enhance the success of the parent as a teacher. In addition, the simple graphic of how to make hand shadow puppets, for example, prompted a substantial increase in the time visitors spent at the exhibit (Perry, 1989).
4. **Familiarity and anomaly.** Have you ever noticed a very young child (two years old or so) looking to find the rest of an object pictured on a screen or TV? Do you recall the scene in the South African film “The Gods Must Be Crazy” (Uys, 1984) where the Bushman was astounded that all the people had been made small and placed inside a telescope? What we already know—from experience, especially—determines whether a new phenomenon is assimilated as basically familiar or treated as something incongruous. The role of anomaly appears critical to sustaining interest, and the degree of anomaly is a function of prior knowledge. Striking a balance between the familiar and the incongruous is made more difficult by the issue in the previous section: the image of the self as a learner.

Often we construe “prior knowledge” too narrowly in educational settings. Creating interest from experience reminds us to think more expansively. For example, when children first begin to use a microscope, they have already had many experiences with turning and tuning knobs, directing beams of light, and looking through tubes, glass, and even lenses. In the informal science environment, children experiment with the microscope and learn through trial and error and guided practice. They bring with them their prior knowledge gained by looking through water glasses, kaleidoscopes, windows, and other objects, as they make sense of their experience with the microscope.

**Summary**

In either formal or informal environments, experience appears equally necessary to creating interest—but the issue of control over choices critically distinguishes between the two contexts, exerting enormous influence over how the experience might be interpreted and understood. Promoting interest in the context of experience means working with language in social situations, where exchanges (clarifications and negotiations) of meaning proceed freely. Language needs to be “about something” to have meaning. Sharing meaning through language creates the possibilities of sharing experiences.

Excessive concern for getting “the right answer” can cause the open exchange of personal ideas to shut down. In contrast, exhibit designers often illustrate through the function of their displays how nature works. The patterns and relationships on exhibit serve as to answer questions authoritatively. Good design lessens the intimidation of “right answer science” and encourages expressive communication and offers children choices in their interaction with exhibit materials.

The role of anomaly appears critical to sustaining interest, and the degree of anomaly is a function of prior knowledge. Learning from experience depends upon the individual’s conception of “self as a learner” in terms of confidence, habits, and dispositions. Children need to learn how to perform both social and personal roles in keeping with a conception of a self as a learner. Ideally, experiential learning in the context of interest as a goal will teach about learning itself. And lastly, creating interest from experience means respect for individual thinking as well as inviting unconventional outcomes.

Designing environments for creating interest means planning for ways to prompt good questions, build on prior knowledge, include choices of activities, promote social interaction, while providing a rich context for communication about science phenomenon. These are the elements of good exhibit engineering. They are also the raw material of classroom interactions in an environment that creates and sustains interest.

**References**


CONASTA 46
Annual Meeting of the Australian Science Teachers Association
June 29-July 4, 1997
University of Melbourne

The Theme
Science Down Under—Extending the Boundaries’ Our aim is to provide science teachers with up-to-date cutting edge information on the thinking of Australian scientists and near neighbours. The programme will also highlight practice and theory suitable for all levels of science education. It is our intention to extend the boundaries of knowledge.

Exhibitions
Throughout CONASTA 46 there will be extensive displays and showcases of science resources, videos, computer software, laboratory apparatus and curriculum materials.

Excursions
A full range of social and informative excursions are being planned to enhance the program. A special Sunday welcome function is being organised, along with a Conference Dinner featuring a mystery tour. A post-conference excursion programme will be available.

Registration
The registration brochure will be available later this year and will be sent to all members of the Australian Science Teachers’ Association. Initial expressions of interest can be filled in on the back of this brochure.

Travel
Qantas has been appointed the official airline for the conference and will be offering discounted conference airfares for conference delegates and accompanying persons. Full details will be included in the registration brochure.

The hard copy of your abstract should be submitted by November 1, 1996. Further information will be required by the STAV Secretariat as soon as practical after this date.

Presenters will be notified of their acceptance of Workshops/Seminars and all presenters are required to register for the Conference.

For more information contact:

Science Teachers’ Association of Victoria,
PO Box 190, Richmond, 3121
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Email: stav@netspace.net.au
June 2-5, 1997
Second IOSTE Symposium for Central and East European Countries Science and Technology Education For Social And Economic Development
Lublin, Poland

The problems discussed during the Symposium will include:

• Development of knowledge in science and technology indispensable at the turn of the millenia.
• Changes taking place in a way of thinking of dents being affected by science and technology education.
• Prospects and citations of integration in science and technology education. Studies in development of cognitive abilities in science and technology education.
• Common research problems in physics, chemistry and biology education.
• Regional cooperation in the field of science and technology education.

The Symposium will be held in Lublin, a town situated about 170 kilometers south-east of Warsaw. It is easily reached by train or bus (travel time: 2 and half hours). Lublin is considered one of the oldest settlement sites in Poland. It is a large industrial and commercial centre, as well as scholarly, cultural and a tourist one.

The Symposium language is English, however, the organizers will provide some help (interpretation into Polish and Russian) for the participants from the East European countries.

Registration fee: 30 USD (IOSTE members 20 USD)
The organizers will do their best to make the participation costs (accommodation and meals) of the Symposium as small as possible.

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June 21-24, 1997
International History, Philosophy and Science Teaching Group
North and South America Regional Conference
Calgary, Canada

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July 19-July 4, 1997
CONASTA 46
Annual Meeting of the Australian Science Teachers Association
University of Melbourne

Science Down Under—Extending the Boundaries.
Our aim is to provide science teachers with up-to-date cutting edge information on the thinking of Australian scientists and near neighbours. The programme will
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October 1-5, 1997
8th International Conference of ISATT (the International Study Association on Teacher Thinking)
Kiel, Germany

The Conference theme is “Teachers’ Work and Professional Development.” The work of teachers is changing due to systemwide policies, global economic and technical trends, equity issues and changes in the nature of school subjects. These trends place teachers in new roles. How do teachers respond? In times of change it is important to consider the implications for the individual, social and cultural development of the teaching profession. What now constitutes, “professional” development? What is the impact of research and curriculum development?

Registration fee will be 400 DM for nonmembers and 350 DM for ISATT members or students.

Information about the forthcoming conference are provided on the Internet:
http://www.ipn.uni-kiel.de/isatt

You may also contact:
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0-24098 Kiel, Germany
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E-mail: langm@ipn.uni-kiel.de

March, 1998
Science & Society: Technological Turn
An International Conference on STS
Japan

Topics to be discussed include the following:

• Network assessment of science
• Transnationalization of Corporate Science
• Technology and Media
• International Relation in the Post-Nuclear Age
• Science and Technology in Asia
• Implication of STS on Science Education, Science Education Policy and Human Resource

Among the invited speakers are: Michel Callon, Sheila Jasanoff, Deepak Kumar, Morris Low, Brian Martin, Aric Rip, Rustum Roy, Song Sang-Youg, Peter Weingart, and Robert Yager.

For more information, please contact:
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New ICASE Member

The Southern African Association for Research in Mathematics and Science Education (SAARMSE) has become a member of ICASE. The correspondent is the Secretary/Treasurer, Mr. Philip Dikgomo, SAARMSE Secretariat, c/o Chemistry Department, University of South Africa, PO Box 332, Pretoria, 0001 South Africa. (e-mail address: saarmse@alpha.unisa.ac.za). The chairman of the associations is Dr. Audrey Ogude in the same University.

SAARMSE aims to promote mathematics and science education research regionally, nationally and internationally by means of fostering a sense of community among researchers in mathematics and science education specifically by:

- promoting research to improve and develop mathematics and science education programmes in southern Africa in response to current and future needs;
- organising annual conferences at which the results of research undertaken by members can be presented;
- assisting in the development of research skills of people interested in entering the field and developing further expertise through organising workshops, short courses and exchange visits;
- liaising with similar mathematics and science education organisations;
- making research results available and accessible to practitioners through conferences and publications;
- building an open forum for debate encompassing research paradigms.

Membership of SAARMSE is open to anyone who is currently engaged in research in mathematics and science education in the southern African region or who is interested in such research. There are currently 700 members.

ICASE/ASE International Seminar

An international seminar will be held in the University of Liverpool, England on 6/7 January 1998, just in advance of the Annual Meeting of the ASE in Liverpool from 8 to 11 January 1998. The theme of the seminar will be New Directions for Scientific and Technological Literacy—the Project 2000+ theme. Keynote speakers will include Svein Sjoberg, Vice-Chairman, IOSTE and Brenton Honeyman, President ICASE. There will be opportunities for paper and poster sessions on the conference theme. Expressions of interest should be sent to Dr. Mary Ratcliffe, School of Education, University of Southampton, Southampton, SO17 1BJ, UK (Fax: 44 1703 593556; e-mail: mrl@soton.ac.uk).

ICASE General Assembly

The ICASE General Assembly—the business meeting of ICASE at which new officers are elected—will be held in the University of Liverpool on 6/7 January 1998, during the international seminar being arranged by Dr. Mary Ratcliffe on behalf of the ASE and ICASE. Full details of the General Assembly will be sent to all member associations of ICASE during June/July. All member associations of ICASE are entitled to send a delegate to this meeting.
Feature Article

EDUCATION IN INDONESIAN PRIMARY SCHOOLS

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Indonesia, a land of 17,100 islands and about 900 distinct cultural groups speaking hundreds of different languages and dialects, is one of the world's most diverse nations. With a population of nearly 200 million, this nation has faced many seemingly insurmountable problems in creating and maintaining an educational system suitable for its citizens. Like many former colonies, Indonesia gained independence in 1945 with only a minimal school system for natives. In 1940, for instance, only 1,786 native Indonesians (out of a population of about 60 million) were enrolled in secondary school programs. Since that time, this rapidly growing nation has made tremendous strides in raising the literacy rate of its citizens, building schools, creating books and curriculum, and educating a cadre of teachers. Much of this has been described in a prior article in this journal (Penick & Amien, 1992).

Using a few primary schools as examples, this paper describes the general nature of Indonesian elementary schools (known as primary schools in Indonesia) with a special emphasis on aspects of classroom climate, including the role of the teacher, the curriculum, and available materials. Our goal of these visits was to provide a brief look into the windows of a few classrooms, giving the reader a view of the conditions as they exist in this culture as we have seen and understood it (Altheide & Johnson, 1994).

While examples were drawn from interviews with only four schools and six teachers during visits to their schools, much of what we describe generalizes to all of Indonesia. The reader should keep in mind that most of our observations were conducted in the area around Bandung, a city of 1.7 million in the west Java highlands. One school visited was near Yogyakarta, in Central Java. But, the centralized curriculum in these schools is the same as in all Indonesian schools, the teachers meet the same requirements (but may have more than the required minimal education), and have attended the same inservice meetings mandated by the Ministry of Education and Culture for all teachers.

Although this is a relatively small and incomplete case study, Stake (1994) points out that case studies are legitimately carried out because of the researchers' interest in the particular case. Our interest was in the potential for understanding more about Indonesian primary education by viewing these rather dissimilar schools. Further, we were particularly interested in the schools of the Bandung region since we were working with preservice teachers who would ultimately be teaching in these schools.

Some Historical Notes

Prior to 1989, Indonesian elementary teachers were required to complete a special high school program preparing them to be elementary teachers. At this time, a new decree from the Minister of Education and Culture created a five-semester, post-secondary diploma program for all elementary school teachers (Dechow & Raka, 1996). With this new program, more than 1 million primary teachers required new training to be considered qualified. New teachers are now completing an additional four semesters of coursework plus student teaching while inservice teachers are receiving six semesters of intensive inservice workshops and courses, meeting 12 hours every week. Thus, almost all teachers have received recent preservice or inservice training. When applicable, reference will be made to teachers' experiences with these training programs.

While the mandated curriculum and the training of teachers is designed to be uniform throughout Indonesia, the reality here is no different than in any other country; as some schools have more resources than others, the training of teachers is not completely uniform, and the level of affluence and education of community varies tremendously. And, usually even those schools with the most resources, when compared to schools in more developed nations, are poorly equipped.

The Ministry of Education views universal basic education as up through grade 9, but only 69% of all
students finish grade 6, 58% finish grade 9, and 51% complete grade 12 (Ministry of Education, 1995). Tertiary education now enrolls almost 10% of the population ages 20 to 24 (Hollinger, 1996). Thus, the high school is almost exclusively preparation for university admission.

Primary schools are arranged into groups of about eight, with specific schools in the group taking the lead for different subjects. Thus, each school (and its teachers) acts as a resource for a particular subject. At least once a month the teachers of the eight schools meet to discuss curriculum, problems, and new ideas.

**Village Primary School**

Located in a small village only 10 km north of the center of Bandung, this school has 300 students, 10 teachers, and 2 principals divided into two separate schools, one in the morning and one in the afternoon. Teachers have 2 to 14 years experience and earn about 220,000 Rupiah per month ($93.61) as a base. On top of this they get a small allowance for having a family and for additional education. The principals each earn Rp 432,000 base. While these salaries are well above international poverty guidelines, they are not adequate to live on. The current (February 1997) mandatory minimum wage in Bandung is Rp 156,000 ($66.38) per month. To put this in perspective, the government describes the minimum wage as the “local cost of a daily caloric intake of 3,000 for a single worker” for thirty days per month (Jakarta Post, January 23, 1997, p. 1). So, these teachers’ salaries will buy about 4,230 calories of food per day, just a little more than what provided by a burger, fries, and a soft-drink in a western fast-food restaurant. Even the principals’ salaries only provide this level of support for three people. As a result, almost all teachers have a second (or even third) job to help them subsist at a minimal level.

**The School Building**

We visited in the morning, just after 8 AM. The school, down a narrow foot path less than 200 meters from a major highway, looks old, run down, and four of the six classrooms are around a small, paved courtyard where students are playing and gathering. The noise from the courtyard permeates all the classrooms, making them quite noisy. The children playing in the courtyard were, like all the children we observed in schools, clean, healthy looking, well dressed in their uniforms, and seemingly quite happy with laughter the norm. Never did we witness any signs of aggression or violence.

**Grade 1—Science**

The 21 first grade students (7 girls), like all elementary students in Indonesia, wore the traditional red shorts or skirts with white shirts and red neckties. Like all six classrooms in this school, the first grade room was 7 x 7 meters with large windows on one side and 16 two-student tables, arranged in a 4 by 4 pattern. Two two-foot florescent bulbs provided light. A blackboard in front, a bulletin board by the single door, and the obligatory pictures of Indonesian President Soeharto and Vice-President Sutrisno were the major decorations in the room. A series of teacher-made numeral charts around the room did add some color and interest. The charts showed each number up to 25 with 7 lemons or 23 apples and so on. There were no materials or other books visible in the room but there was a large cabinet in the corner. One electrical outlet was visible by the side bulletin board.

During our visit, students finished a math test and, with little teacher instruction, were working on assignments from their books. Minutes after beginning, few were on task and almost all were talking quietly with each other, looking around, or just sitting. They were very polite, though, and not being behavior problems. The teacher was at her desk in the front of the room, grading the tests students had just completed. There was no sense of discomfort on the part of students or teacher, leading us to believe that this was a normal part of the school routine.

Students were using a 96 page student text, the second of a two part series. The problems seemed typical of elementary texts with a lot of circle the number, writing by tracing dots, addition of single and double digits, and the beginnings of subtraction. Quite a few word problems were evident and the reading level seemed quite high for first grade.

The assignment book, 41 pages long, integrated arithmetic, Bahassa Indonesia (language study), handicrafts, and cursive writing. The level of reading again seemed high and the first 22 pages were word problems, writing assignments, and a little traditional arithmetic. The arithmetic sections included counting, logic, exclusion, word problems, subtraction, and even some geometry of angles. There are a few activities where students cut and fold to create shapes. Students must each buy all of their own textbooks. In a local store the books ranged in price from $1.50 to $4.00 each. With primary age students needing as many as 8 books per grade level, a teacher can barely afford to provide books for her own children, much less provide science materials for her students. The cost of books,
transportation to the more distant secondary schools, and lunch probably help raise the cost and the dropout rate significantly.

After the teacher finished grading the tests, she had students clear their desks and then began talking to them, very, very loudly to compete with noise from the courtyard outside. While this teacher, like all, has attended workshops and courses on student-centered learning, she read questions and the students shouted out the answers. The students, having no materials other than books, easily see the teacher as the center of attention. The same behavior is true in science, where the amount of equipment is only adequate for limited demonstrations. Even for this, little was done as the teacher said she was afraid of breaking the limited science equipment available. Like we have seen in many teacher-centered situations, near the end of class the students all put on their backpacks early, ready to go at a moment’s notice.

The class ended with the students, in unison, very loudly reciting a lengthy prayer. Most students were shouting it out, clearly in the appropriate spirit of the moment. When the time came, the teacher dismissed them by row, according to who was good. As in all classes we observed, behavior problems were rare, even though the students have few materials to engage them.

Grade 2—Science

Taught by the same teacher and in the same room as the first grade class just described, the new class entered, very noisy and happy. As soon as the students dropped off their backpacks, they left to go outside. Almost immediately, six students picked up small brooms and began putting up the chairs and sweeping, somewhat randomly but with obvious intent and practice. The teacher was not overtly organizing it in any way, just standing by her desk. On the bulletin board a listing showed which students were responsible for cleaning each day.

After a 15 minute break for snacks and sweeping, the students returned. These 25 (14 girls) began by reciting a prayer out loud. Again, they were very loud and eager. After the opening prayer, the teacher erased the board, slowly and carefully while the students milled around, some out of their desks. After some rearranging of students so that only two students were at each table, the teacher began asking questions and the students, as before, shouted out answers in unison. The topic was The Use of Money. For materials, the teacher went to her purse and collected some money to use in the presentation. She held up paper bills and would ask students to tell the denomination. As before, students shouted out their answers, eagerly and accurately. Most quickly recognized the color and size of each bill and did not even need to see the numerals.

This teacher, in both classes, spent almost all of her time in front of the room, leaning on a student table slightly to the left of center, near the windows. She had to shout to be heard above the noise from outside, which never ceased. She focused most of her attention on the left side of the room, perhaps because she was on that side of the room or perhaps because the observers were in the right rear corner. Several times during the first 10 minutes groups of students came in noisily, got brooms and then left. Each time, the teacher followed them and patiently closed the door behind them. Following 15 minutes of identifying currency, she assigned students problems from their text. Returning to her desk for more paper work, this continued to the end of class.

Grade 6—Physical Education

The teacher, a young man, teaches physical education half time in both the morning and afternoon schools. This room was even more bare than the first and second grade room. Other than 18 two-student tables in this 7 x 7 meter room, only a teacher’s desk and wobbly student benches were visible. Many of the table tops had serious termite damage which would make it difficult to write on. The backboard, about 1.5 x 3 meters, rested on a makeshift easel. As before, two two-foot florescent bulbs lit the room along with six small windows. One electrical outlet by the door was available. No teacher-hung materials and no equipment were visible. And, since there was no cabinet in the room, there could be no hidden equipment. The room is used for teaching all subjects to the sixth graders.

The 25 students (10 girls) in this morning class were listening to the teacher describe rules of soccer, the size of the field, and so on. The boys occupied all of the center two rows with the girls on the outside two rows of two-student tables. Seven girls were to the teacher’s right and three to his left.

The teacher wrote questions on the board and then students wrote down the answers on their papers. Following this, the teacher would ask the questions and students would shout the answers out. Unlike the grade one and two classes, only about half the students were involved in the shouting; most were passively sitting, especially the girls. The teacher was nearer the boys, talking directly to them, and never looking to the
side with the seven girls. Sometimes the girls had answers but, unlike the boys, they raised their hands and rarely shouted out their answers. And, when they did shout out, they did not do so as loudly as the boys. In thirty minutes of observation, the teacher never looked their way or recognized any of the girls, even when they had their hands raised.

Grade 6 science books presented many student activities using simple equipment such as magnets and electrical components and included a variety of practical applications such as plant propagation. But, none of the materials necessary for any of the activities were visible. The principal said there were some materials but they were locked up and he did not have a key. He was referring to the recently developed science kits that had been distributed to every primary school in the country. These kits contain a very small tuning fork, two 50 ml syringes, a knife switch, two flashlight bulbs (but no batteries), 6 small magnets (including a cover to make a compass), iron filings, a few pieces of wire, a few other items for physics, and a collection of biology charts which stress the labeling of body or plant parts. There are no chemistry activities and none that looked like earth or space science.

The Principals’ Office and the Teacher’s Lounge

At the west end of the school courtyard was the principals’ office, a 2 x 4 meter room containing a well-worn couch, a chair, a file cabinet, and a small desk. The walls were bare except for two large dry mark boards listing all of the staff and their relevant data such as birthday, age, experience, salary, and educational attainment. At the east end of the courtyard, a slightly larger room served as a teacher’s lounge. This room had a collection of textbooks, a class schedule, a room to store some materials, and a shiny new world globe. This was the only piece of non-text teaching material we saw in the school.

The science textbooks had an obvious UK and American influence and most were dated between 1994 and 1996. All contained a number of activities appropriate to the grade level. While some readings and activities were rather abstract, they tended to be quite short. The grade six teacher, a well-groomed and neatly dressed woman with eight years teaching experience and a full four-year university degree, said that she could only teach the theory of the science since she has no materials. The principal looked uncomfortable as she said this. Yet, the books usually call for only simple materials such as paper clips, razor blades, soil, seeds, and the like. Even batteries and bulbs should be not too difficult to obtain in Indonesia. The teacher however, like many others here, explained that it was not her role to buy or even obtain the materials needed to teach properly.

IKIP Primary School

Nunan, a 28 year old male with 7 years experience teaches 5th grade and Mimin, a 28 year old female, also with 7 years teaching experience, teaches 4th grade in what was once a teacher’s college laboratory school. The school now has 520 students and 24 staff members. A few months earlier, these two teachers both attended a two-week national workshop in Jakarta designed to teach them how to use the elementary science kits and how to teach their use to other teachers in their region. The school has been nominated as a science flagship school because these two teachers (plus one other) completed a special course in Jakarta and because the school has resources in science that other schools do not have. They had a wall of science equipment, including glassware, models of human anatomy, and the science kits. These materials are not stored in the classrooms.

Nunan and Mimin described the two-week workshop as beginning with a full day of ceremonies and then a second day of lectures about the procedures of the workshop. Thus, they had only 12 days of actual in-service in the use of the kits. Both Nunan and Mimin felt that they needed more time to really become competent in the use of the kits and in how to teach others to use them.

At the workshop, they were divided into three groups representing Physics, Biology, and Earth/Space science. Each group rotated through the topics, spending about 4 days with each topic area. Physics had the most experiments, biology was more descriptive and vocabulary-intensive. Earth/Space science had few activities and there were no chemistry activities.

Mimin and Nunan said that the workshop taught them how to take students out of the classroom and use the outside world for teaching. For instance, they did some simple ecology by picking up moss-covered rocks and looking for organisms. They also had worksheets to fill out that included questions such as: “What animals and plants can you find?” “Where do they live?” “What do they eat?” and so on. Both teachers felt they learned a great deal in this way. And, they learned how to supplement the curriculum with materials and ideas of their own design.

In physics, they said the workshop focus was more on teaching the teachers the content knowledge while
doing a few simple activities with electricity, magnetism, and sound. Since each participant had a science kit, they did get significant hands-on experience. Biology was more a review of plant and animal anatomy and related vocabulary. Earth/space science activities include mapping and compass use as well as paper airplanes.

While these two teachers said that the workshop did influence their own teaching and that they now do some simple demonstrations in their own classes, they are still quite teacher-centered, even though the intent of the workshops was to move teachers toward an activity-based curriculum. Unfortunately, they said they still do not have enough materials for more than demonstrations. While both teachers indicated that they also learned how to improvise and create equipment, neither indicated that they were doing this in their own teaching.

On the positive side, Nunan said that as a result of the workshop he now teaches more about nutrition, including the importance of fats, proteins, and carbohydrates in nutrition. He has students identify the fats in foods by rubbing them on paper. He felt that the workshop was quite useful for him and he recommends it to others. He has also continued his learning since he team taught (with two other teachers) a similar, six-day workshop to 100 teachers in the Bandung region the month after the workshop he attended. The 100 teachers shared 20 science kits that were borrowed from nearby schools. Nunan felt that teaching about the kits allowed him to become more confident about his knowledge and teaching skills.

Mimin said that she is now more flexible in her teaching and less worried about exactly meeting the national curriculum guidelines. She now understands that she can and must modify the curriculum to best meet the needs of her students. She did say that she feels she needs more workshop time, as 12 days was only enough time to see a few examples and not nearly enough time to really learn to modify existing materials or to develop new curriculum. Neither teacher mentioned anything in the workshop related to how they were expected to teach, even though this is designed as one major focus of the two week experience. As seems to be the case in almost all cultures, it is easier to change the curriculum than to change the role and behavior of the teacher.

Grade 4—Science

After talking with Mimin and Nunan, we went to Mimin’s classroom. Her room is 6.5 x 9 meters with windows along both the long sides. Open louvers are above about half of the windows. One door opens to the hall and another goes to a brick-paved courtyard adjacent to the high school. Six florescent fixtures hold a total of 12 four-foot bulbs. One electrical outlet is in the front, above the raised teacher’s platform that extends across most of the width of the room. Three bare wires protrude from next to the light switches, where another outlet may have been. There once was a sink in the front but all that is left is the tile backsplash and a bent water pipe protruding the wall. The high ceiling has numerous cobwebs hanging down and is quite dirty. It has been many years since the room was painted.

In addition to the teacher’s desk located on an 8-inch high platform in the front, there are some overhead cabinets in the rear and two metal cabinets in front. All the cabinets have graffiti scrawled on them, mostly obscenities in English! Students sit at two-person tables, arranged in five rows of five tables each. Girls are seated with girls with one exception, table 12. Student work is glued (not taped as tape is harder to obtain) to the walls in a number of places. Often, the student papers have been stamped with a rubber stamp that says “Good Student!” (also in English).

Mimin’s class was in the second day of making paper airplanes. The prior day they read in their books, Sains 4-B, about how to make them. The book contains several diagrams about how to fold paper into airplanes. Each student had taken one of these designs (or one of their own) and drawn their own plans for making the airplane. The 41 students (23 female) were organized into groups of three. On the day we observed, a teacher education graduate student was collecting data and had given each student a name tag. All students were well-equipped with paper, rulers, scissors, colored pencils, glue, and even tape. Some had stick-on letters and decals. Their task was to make the paper airplane they had designed the day before. After folding their paper planes, they were going to fly them outside.

The designs the students had drawn may have been copied but they had not been traced. They were generally very neat drawings, with great detail. All of the fold lines were indicated with dotted lines. Following some initial instructions, all students were soon folding their airplanes, following the instructions of their designs. They all were on task and seemed quite intent on their work.

The teacher circulated, speaking softly to one group at a time. She gave little in the way of directions, letting the students work on their own. Initially, there was little
talking, even among students at a single table. Ten minutes into the lesson there was more student talk, but usually lesson-related and confined to a single table. They were still very much on task, though. Several students re-drew their plans, after trying to use them. Students seemed genuinely interested in what they were doing, looking very serious as they worked.

Twenty-five minutes into the lesson, students were still very much on task. By this time, many had made two or even three airplanes, each different. Most students were very thorough, coloring, gluing, and adding aesthetic elements. None indicated any interest in the graduate student who was videotaping with a hand-held camera. And, almost no one paid any attention to an American in the room, even though they are rare in this part of Indonesia.

Next, the teacher, speaking very loudly, gave new directions about the next phase, going outside to try the planes out. Each table straightened up their materials and then sat quietly, waiting. Table by table, beginning with the front, the teacher then dismissed them to go outside. In the courtyard, students assembled in a U shape, with the teacher at the open end and the wind coming into her face, from behind the students.

The first team, from the bottom of the U, took a few steps forward, looking toward the open end of the formation. One at a time, each member of the team threw a plane, groaning and laughing when their planes fell short and shouting and laughing at a good throw. Generally, though, for the first six students, there was little success as they were throwing with the wind. One observer asked the graduate student about which direction airplanes usually take off, into the wind or with it. She quickly took that hint and spoke to the teacher, who turned the whole formation so they would be now throwing into the wind. The next throws were more successful. Then, of course, the wind changed. Resourcefully, the teacher now asked each group to fly their planes in both directions. Unfortunately, she did not ask students to measure the wind direction and correlate it with their flying success. In fact, no measuring of any kind was being done. The essence of the activity was to design, make, and fly the planes. At no time did we note students measuring, analyzing, or considering variables, much less manipulating or controlling them.

When Firman, the smallest boy in the class, came up to throw his plane great laughter erupted and we heard even more when his plane went by far the greatest distance, in both directions. The class also loved it when his first throw hit one of us, Achmad Hinduan, in the head.

After 15 minutes, only 9 students had thrown their planes, with 26 to go. It seemed a bit slow. At this time, eight of the boys were throwing independently, behind the formation of students. Soon, more than half the students were throwing on their own while the teacher continued working with the single team in the middle of the courtyard. Noticing the wayward students, she gently called them back to order and moved quickly through the procedure up to group 10. By this time, the boys were off on their own again. This time, the teacher did not call them back into the group.

Twenty-five minutes after the first throw, all had thrown at least once in the middle of the courtyard. The teacher brought them back into the group formation and called a few students, one at a time, into the center to see how far they could throw. The teacher chalked the point of impact of the airplanes of the first two boys and then, somewhat abruptly, sent the students back into the classroom, table by table just as they came out.

The graduate student gave each table a sheet of construction paper and students began attaching their planes to the paper. Each table would have a display of their work. In twelve minutes, almost all students had finished and were off task, talking loudly, bouncing things off the floor and tables, and creating a lot of noise. Several boys literally began climbing over the tables. During all of this, the teacher watched calmly from the front. Then, after consulting her watch, she began calling out table numbers. Quickly, every student was seated, the tables became quiet, and they began cleaning up. Then, looking only at the front, center tables, she dismissed them. Students left in no particular order, slowly, in no hurry, on their way to a recess. Even five minutes after this dismissal, most were still near the doorway but outside the room. When the teacher asked them to pose for a picture with the visitors, most were right there, waiting for the photo opportunity.

**Urban Primary School**

Located closer to the center of Bandung on a major road leading out of town, this school had 21 staff and almost 500 students. Like the other two schools, this one needed some repair and there was not enough room for the students in class or out. The classrooms, while relatively bare, had some basic equipment, although it did not seem to be used very often.
Grade 5—Science

The lesson was about soil, and began with a whole group discussion about how humans and other organisms need soil, where it comes from, and how it relates to the economy. The children went outside to investigate soil in the schoolyard, with specific directions to compare bricks which had moss growing on them to bricks which did not. The activity was taken from the student text. The teacher, who had attended the Jakarta workshop, had a very friendly and supportive manner, and was very encouraging children and worked hard to maintain their involvement. She seemed not too concerned about noise level and seemed to expect active student involvement. The 46 children in the class (21 girls) were very active, and were keen to answer questions, even calling out at times so that the teacher had to ask them to put up their hands.

Back in the classroom, the teacher split them into 5 groups of 9, and circulated around, encouraging them and clarifying the task each group was assigned. The lesson ended with the teacher taking what she wanted out of their oral reports as she summarized the ways in which rocks are eroded to form soil.

She next assigned homework, in which members from each group were nominated to bring a can with soil collected from near a river, in the garden, in the yard, and from a rice paddy.

The lesson provided for student input and for active investigation but we did not see any real opportunity for the children to discuss their ideas, generate any new directions, or ask any questions about the ideas. The teacher was firmly in control of the flow of concepts, which she did very well. While the learning was "active" in the sense there was student input and hands-on investigation, it was not the constructivist classroom promoted by the Jakarta workshop.

Grade 6—Mathematics

The two classes were somewhat drill-and-practice in nature, although one class in particular seemed very thoughtfully run and the teacher had prepared his own problems on the board as a revision exercise and the students were working through these. Both these classes were much quieter than they had been previously. The two teachers wrote problems on the board and students came up to solve them. Students at their desks copied down the problems and the solutions presented. As each student finished a problem, the teachers would ask questions, raise issues, and correct the work. On several occasions, the teacher asked another student to come to the board to try the problem. As this happened, students at their desks could be seen erasing their notes.

Mountain Primary School

Located north of Yogyakarta, this small school had only 200 students and five teachers. The five classrooms were in a one building which had windows down both sides. An area above the windows was screened and open all the time. Each room was almost identical, with bare walls, old furniture (usually two-student desks with benches), and badly in need of basic repairs to the walls, roof, and grounds. A small dirt playground faced the front of the school building. On the day we visited, we counted only 130 students in all of the classes.

Grade 1—Science

The teacher, a woman with 15 years experience and little inservice training except for a recent workshop on student-centered learning, was working with students on their leaf collections. She said that her recent workshop had led her to try some new things with her students. She chose a leaf collection as a way of getting her students more involved, outside, and avoiding the need for expensive materials. As we watched, her 27 students (12 girls) were in groups of two, sorting their leaves, talking, and tracing around the outsides. Later, they would try to match the leaves to the drawings as a way of testing their skills. Students told us that they had collected the leaves themselves and the teacher had only told them to find 25 different types of leaves.

After 15 minutes, the teacher began talking to the entire class, reminding them of her directions (to draw the leaves, mount the leaves on a piece of colored paper, and how to indicate their names). Then, for 10 minutes, she asked a series of questions, almost all of which could be answered with a simple "yes" or "no." Only in a few instances did a student answer in a full sentence and none volunteered any extra information. Students responded well, however, with many eager hands raised to answer. The class, like all we have seen in Indonesia, were very polite to the teacher and to each other. At the end of the lesson, the teacher told students to put their collections on a table at the back corner of the room. They did so and then she dismissed them to go outside for morning snacks.

The teacher told us that tomorrow, after mounting their leaves, they will hang them on the walls. She will then ask each group to stand by their collection and tell the class about their leaves. She said this is a technique she learned about from another teacher in the workshop.
she attended. When we asked if this activity was in the official course description, she told us that it was not but that the lesson helped students to classify, to observe, and to communicate, all goals of the syllabus. We thought she had a strong rationale for how she was teaching.

**Grade 4—Science**

The teacher, a 27 year old male, does not like to teach science. He says he much prefers social studies, art, and physical education. His science lesson for today was about energy transfer in the environment. The 39 students (19 girls) were sitting at tables for two but working independently. They were drawing pictures to depict energy transfer. Almost all students had basically the same drawing—a sun in one upper corner, a lake, trees, a few scattered plants, and a few animals such as birds, tigers, and even an elephant. Students were drawing arrows connecting the sun with the various plants and animals. When we asked students how the energy got from the sun to the organisms, many could not answer and some replied that it was heat energy. When we went on and asked where the sun got its energy, we were met with blank stares. Two students responded by drawing arrows from the trees to the sun.

While the students drew, the teacher sat at his desk, reading papers from a previous class. At no point did he move among the students to ask questions or even to make himself available. After 15 minutes, he told the students to set their drawings aside. He then proceeded to lecture about energy cycling, the water cycle, trophic levels, and decomposers. Some students took notes but most just listened and watched. The lecture continued for 15 minutes and then told the students to take out their textbooks and begin reading. They read for almost 20 minutes, talking quietly to each other, while the teacher sat at his desk and continued reading the papers he had there. Then, he dismissed the students by table and they left the classroom.

When asked, the teacher said he had attended the inservice for student-centered teaching. He felt that the drawings they were making were student-centered in that they were each making their own drawing. He said that he had to lecture to them because they did not know enough to understand energy flow on their own. Tomorrow, he said, he planned to continue the lesson by teaching about photosynthesis.

**Some Conclusions**

Like most settings, the primary schools and teachers we visited in Indonesia were teaching in a variety of ways. Many were deviating from the syllabus or text but most were still quite teacher-centered. Students were on-task but we saw almost no examples of students making decisions, designing experiments or devices, or evaluating. Almost every lesson could have been easily modified to include these components.

The teachers all seemed well-prepared, professional, and fully in charge of their classrooms. They were not afraid to have us visit and were eager to talk with us. This has not always been the case as we visit classrooms, especially in primary schools. We take this to mean that these teachers were confident, had nothing to hide, and were open to ideas.

Unfortunately, we found all the schools to be ill-equipped, the teachers to be under-educated, and the physical setting of the classrooms to be dark and drab. The intellectual climates varied more but still tended to be closed to new ideas, and no evidence of student experiments were noted. By experiment we mean where the student identifies the problem, designs solutions, undertakes the needed activity, and then evaluates the result. Instead, we saw what is typical in almost every country—the teacher identifies the problem and, at best, the student devises a solution. While this is efficient to covering the content, it does little to teach students how to think critically and presents science as a static and dogmatic field of study.

**Some Thoughts for Future Study of Schools**

This brief look at a few classrooms does not allow for generalization. We need to have many hours of visits to numerous classes in a large variety of schools before we may generalize far. The visits need to become more systematic, including more fully capturing the behavior and role of students and teachers. These brief snapshots are just that, a point in time that may or may not be representative of that teacher, class, or school. We look forward to reading such reports from others and to making such observations ourselves in the future.

**References**


Author Penick and the staff of village Primary School. The first grade teacher is on the left, the morning principal is third from the left, and the sixth grade PE teacher is second from the right. The two men in brown uniforms are security personnel.

Authors Hinduan and Penick in the first grade classroom.
THE LABORATORY ENVIRONMENT: AN ECOLOGICAL PERSPECTIVE

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Introduction

Toward the end of the Origin of Species, Darwin writes a lyrical description of the interrelationships found in one small region of nature, a river bank. He suggests that his readers contemplate

a tangled bank clothed with many plants of many kinds, with birds singing on the bushes, with various insects flitting about, and with worms crawling through the damp earth, and to reflect that these elaborately constructed forms, so different from each other, and dependent upon each other in so complex a manner . . . (Darwin, 1986, p. 373).

In this passage, Darwin seems to anticipate a holistic approach to scientific investigation, the view that a complete understanding of any phenomenon cannot be achieved solely by studying the parts in isolation from each other. In fact, a definition of ecology, "the scientific study of the interrelationships between living organisms and their environment, including both the physical and biotic factors and emphasizing both interspecific and intraspecific relations" (Walker, 1988) seems to be central to Darwin’s thinking long before the birth of the formal discipline of ecology.

In reflecting on Darwin’s words and the modern description of ecology, another environment comes quickly to mind—the school science laboratory. Of all teaching venues, there is little doubt that the laboratory is among the most complex. Hence, the central thesis of this paper is that the school laboratory is best viewed and studied as a rich environment with its own unique interplay of variables and interrelationships. Viewing the laboratory milieu from an ecological perspective can provide educators with a new understanding of the way in which relevant factors interact to support or block learning and suggest ways to enhance assessment of both students and laboratory activities themselves.

Historical Perspective

The laboratory has been widely-used in science instruction for almost a century and is now considered central to science instruction by many teachers. Weiss (1987), reporting the results of a nation survey of science teachers, found that twenty-one percent of total class time in secondary school science instruction is spent in hands-on or laboratory work. In addition, 80 percent of the teachers surveyed agreed or strongly agreed that laboratory-based science classes are more effective than those featuring lecture alone (Weiss, 1987). Even the new science teaching standards count investigative activity among those skills vital to achieving science literacy (National Research Council, 1994).

This interest in and appreciation for the laboratory in science teaching has spawned a virtual research industry. As Tamir (1994) states, “perhaps no other area in science education has attracted so many research reviews as learning, teaching and assessment in the laboratory” (p. 94). Unfortunately, as Blosser pointed out following her comprehensive review of research and opinion regarding laboratory instruction, “most of the research done on the role of the laboratory finds no statistically significant difference in achievement or attitude or lab skills between students given experiment-based lessons and students given lecture-based lessons” (Blosser, 1988, p. 57). “Despite this long history of investigation, science educators are
unable to provide a large amount of evidence in support of the contention that laboratory work would continue in science classes” (1981, p. 126).

Science education therefore is challenged by the realization that teachers will continue to engage students in laboratory experiences, science educators will persist in recommending the use of such inquiry experiences and researchers will continue to strive to show empirically that laboratory work is defensible. Perhaps we have been engaging in an incorrect perspective with respect to research and practice in the laboratory since most studies have examined single isolated laboratory variables. A more holistic view of this unique environment seems reasonable as the laboratory begins its second century of widespread use.

Holistic Study of the Laboratory

The proposal presented here, that the laboratory is best viewed environmentally, has its roots in several kinds of studies. First, much insight into the complexity of laboratory teaching may be gained by reviewing the inventories, checklists and interaction coding instruments that have been specifically designed for use in investigative settings such as laboratories. These schemes are based on a rich view of the relationship between the pedagogical, curricular and interpersonal domains occurring in the laboratory.

In developing a quantitative interaction coding instrument, Smith (1971) was among the first to examine the laboratory teaching environment holistically. Smith’s work was followed by that of Eggleston, Galton and Jones (1975) who produced the Science Teaching Observation Schedule. Another instrument fashioned specifically to examine interactions in the general science teaching laboratory was Science Laboratory Interaction Categories (SLIC) with one scheme to survey teacher roles (Shymansky, Penick, Kelsey & Foster, 1976) and another to help visualize what students do in the laboratory (Penick, Shymansky, Fikins & Kyle, 1976). Other tools for laboratory interaction analysis include those by Power and Tisher (1976), Guy (1982), Beasley (1983), the Laboratory Observation Schedule of Friedler and Tamir (1984) and Hegarty-Hazel’s (1990) System for Observation of Laboratory Behaviour: Tutors/Students (SOLT/SOLS).

A related approach, the Science Laboratory Environment Inventory (SLEI) was developed by Giddings and Fraser in 1989 as reported in Giddings, Hofstein and Lunetta (1991). SLEI was developed to assess student’s perceptions of the actual and preferred laboratory environments, but nevertheless is a useful source of guidance in the development of a description of the principle laboratory variables.

Qualitative examinations of the laboratory environment provide another valuable source of data. Stake and Easley (1978) were among the science education pioneers viewing science teaching itself qualitatively. Their now-classic case studies offer a number of clues into laboratory teaching. Other useful holistic studies include those by Tobin and Gallagher (1987), DeCarlo and Rubba (1991) and Solomon (1991) all of whom have examined aspects of laboratory culture.

The Laboratory Environment: A Proposed Taxonomy of Principle Variables

The following proposed taxonomy (Table 1) of the principal components of laboratory instruction results from several types of analysis; a thorough review of the qualitative analyses and underlying assumptions found in various quantitative interaction coding plans extensive personal investigation of laboratories (McComas, 1991). The final product was filtered through a wide number of practicing teachers who drew on their vast practical experience in the classroom to check for missing elements and review for comprehensibility.

Interestingly, the two major categories—physical factors and personal factors—are closely related to the biotic and abiotic elements found in lists of variables associated with inspections of environments in nature. In the case of the laboratory, variables categorized as ‘physical,’ are those that would generally exist even in the absence of learners and teachers. Issues such as the amount of time available, the arrangement of the room, the level of openness of the activity, and the relationship of the laboratory lesson to the remainder of the lesson exist even if no one actually does the activity. However, included in this category are some issues that require some student-based reference point such as the difficulty of the activity, safety concerns, and even the amount of time required by different students.

In the second major category of the taxonomy are issues pertaining to the human dimension. Student-related issues include both individual factors such as prior conceptions and experiences, psychomotor skills and psychological aspects such as attitude, motivation, and curiosity. Classroom dynamics (for example, class size and cooperative learning) are also included within the student division of the classification scheme. The nature of the verbal questions asked, goals and expectations held by the instructor, the knowledge base of the teacher, the teacher’s comfort level and the role of the instructor are all included in the list of the factors related to the teacher.
Table 1. A proposed taxonomy of the major physical and personal and psychosocial variables found in the laboratory teaching environment.

1.0 PHYSICAL FACTORS

1.1 Physical Arrangement (and limitations) of the Laboratory
   1.11 Space considerations
   1.12 Furniture and workspaces
   1.13 Ambiance of the room

1.2 Time Issues (Requirements and/or Constraints)
1.3 Laboratory Setting (Where is the laboratory conducted?)

1.4 Equipment
   1.41 Equipment available (to the instructor)
   1.42 Equipment available (to the students)
   1.421 Storage of equipment (Is it visible, accessible and open or closed?)

1.5 Curricular Issues (Linked to a specific activity)
   1.51 Goals of the laboratory (stated or unstated)
   1.52 Choices (problem, procedures, data collection and display modes) to be made by the students (student discretion)
   1.53 The problem to be investigated (teacher or student generated?)
   1.54 Exercise difficulty (clarity of task, number of variables, etc.)
   1.55 Relationship and positioning (timing) of the laboratory to instruction with respect to the lecture, text and the curriculum
   1.56 The level of difficulty of the written laboratory questions
   1.57 Assumptions of the laboratory (language, computation necessity, technical skills, developmental level, etc.)

1.6 Safety Concerns
1.7 Assessment Issues

2.0 PERSONAL FACTORS

2.1 Student-Related Issues
   2.11 Student’s Cognitive Abilities
      2.111 Prior conceptions (knowledge) held (supporting and blocking understanding)
   2.112 Student’s comprehension and reading abilities

   2.113 Student’s perceptions of the nature of science
   2.12 Psychomotor Skills Required by Students
   2.121 Students with special physical needs and limitations
   2.13 Prior Experiences
      2.131 With labs in general or with specific types of exercises
      2.132 With particular technical skills
   2.14 Student’s Psychological Nature
      2.141 Attitude
      2.142 Motivation
      2.143 Maturity/Responsibility
      2.144 Learning styles
      2.145 Confidence and Self efficacy
      2.146 Creativity
      2.147 Curiosity
      2.148 Interdependence and Independence

2.15 Classroom Dynamics (Relationships among students)
   2.151 Number of students in the class
   2.152 Grouping issues (arrangements, dynamics, etc.)
   2.153 Level of individual participation (opportunities for all to participate)
   2.154 Opportunities for cooperative learning and peer coaching

2.2 Student-Teacher Issues (relationship between students and teacher)

2.3 Teacher-Related Issues
   2.31 Teacher’s Role (Facilitator, Dictator, etc.)
   2.32 Nature of Questions asked Verbally
   2.33 Expectations of the Teacher
   2.34 Level of Approachability
   2.35 Knowledge (experience) of the Teacher
      2.351 Content knowledge (of a particular phenomenon)
      2.352 Curricular knowledge (where to get good labs)
      2.353 Pedagogical knowledge (how to instruct in the lab)

2.36 Teacher’s Psychological Nature
   2.361 Comfort Level
   2.362 Confidence
   2.363 Enthusiasm
   2.364 Values (Does the teacher value laboratory experiences?)
Applying an Environmental View of the Laboratory

The intention here has not been to produce the definitive list of laboratory variables. In spite of the care taken in the development of the list, this proposed classification scheme will certainly be amended as our knowledge about laboratory learning grows. Even in a tentative state, the view presented in Table 1 can be useful in three general ways; to further research into laboratory teaching, to impact teaching practice and related teacher education programs and affect assessment of both learners and practitioners in the laboratory.

In the realm of research, decades of commentary on laboratory teaching practice criticize the cookbook-like aspect of many exercises. Various studies of the laboratory have shown that it is effective to have students work first on the investigative component before class discussion of the phenomenon while other studies demonstrate that as the number of student choices increase, many students perform at higher levels. While these studies seem conclusive, what is missing is an examination of the extent to which their implications should be implemented.

For instance, in the interrelationship of variables found in the laboratory, while some students may certainly benefit and become empowered by having to make more choices in the laboratory. This suggestion may dissuade other learners because of their prior conceptions of what laboratory work should be or their lack of skills needed in a different environment. At the same time, the teacher variable comes into play. If teachers are not comfortable with their new role as a facilitator, classroom behaviors they apply may not support an increased level of student decision making. Therefore, from the perspective of research, it is vital that we investigate not just single variables but the effect that one aspect of the laboratory may have on others. In fact, many new research questions may be asked simply by looking at the issues contained in the classification scheme.

Practitioners too can benefit from an enhanced view of the laboratory as an environment. Dreyfus (1986) has shown how the same laboratory activity can be modified for learners of differing abilities by focusing on many of the issues presented in the taxonomy. For example, an exercise with several variables may be adjusted by having students concentrate on a single issue. Also, the written laboratory questions could be adjusted in difficulty by knowing something of the nature of the learners. Even extending the time available for the activity with some students can make a significant difference in the kind and depth of the learning that takes place. Only through knowledge of the variety of issues relevant to laboratory teaching can teachers make judgements about how to adjust particular activities to suit the goals they hold for laboratory instruction. Of course, with implications for practice also come implications for teacher education. Rarely is the laboratory discussed as a unique science teaching environment. Perhaps reference to the proposed taxonomy by methods instructors will provide motivation to include aspect of laboratory learning in programs designed to educate science teachers.

Finally, the assessment arena can be greatly enhanced by referring to the laboratory taxonomy. The finding that it is difficult to defend the laboratory based on research may be an indication that the wrong association of laboratory variables was applied in the design of particular activities or that incorrect student outcomes were examined. If laboratory assessment focused on the development of particular psychomotor skills, the improvement of scientific attitudes or even the enhancement of confidence, curiosity or independence, the laboratory experience may suddenly be seen as quite valuable. Unfortunately, these areas are rarely mentioned as goals for science instruction by teachers perhaps because teachers are unaware of the potential of the laboratory to develop these areas.

In conclusion, it is time that educators cease viewing the laboratory as simply another type of classroom. Classrooms can be complex environments in their own right, but the laboratory presents an even more intricate, involved and dynamic association of personal and physical factors. These factors must be taken into account by researchers and practitioners if the laboratory is to be studied and applied properly. Darwin concluded Origin of Species with the oft-quoted phrase, “[t]here is grandeur in this view of life . . .” (1986, p. 374). I would like to suggest that there is also a certain majesty to be found by examining the laboratory holistically. To paraphrase Darwin, an environmental perspective reveals the grandeur in this view of the laboratory.

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HELPING STUDENTS UNDERSTAND THEIR OWN LEARNING THROUGH THE USE OF LOG BOOKS IN A SCIENCE CLASS

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Abstract

Students often see science as a subject that requires learning to simply be a matter of knowing, being able to use the right formula at the appropriate time, or being able to balance equations. Perhaps more than in other subjects, they also often see the teacher as the “font of all knowledge.” Because this view is often to the forefront of students’ thinking about science, they often undermine their own ability to think and learn in ways that science teachers themselves consider to be much more important. This paper is about how one teacher attempted to dispel the “I talk, you listen, do and learn” approach to science learning by introducing log books as a basis for the development of greater student responsibility for learning.

Introduction

Too often teachers experience a feeling of dissatisfaction with a lesson or a unit of work. Ideas and questions run through one’s mind: “Is there a better way of teaching this concept? I thought I explained it well but the students did not seem to understand it.” Dissatisfaction is felt as a sense of frustration or confusion about student learning (or the lack of it), and is exacerbated by assessment procedures that may not allow students to adequately demonstrate their understanding. The relationship between student learning and a teacher’s approach to teaching is central to professional satisfaction, yet little of the struggle to better relate the two is reported by practitioners. The tradition of working behind closed doors in one’s own classroom often hinders the free flow of professional knowledge amongst teachers. What many teachers view as good ideas or innovative teaching strategies are in fact much more, they are attempts to better relate teaching and learning. Promotion of these ideas should become more a part of professional dialogue so that our understanding and valuing of teachers’ professional knowledge is enhanced.

In this case the link between theory and practice was facilitated through a professional development in residence program (Loughran, 1994) and the incorporation of a Children’s Science approach to teaching (Driver et al., 1985; Osborne & Freyburg, 1985; Gunstone, 1990). The professional development in residence program was a way of ensuring that professional development was available to teachers at the school site. The science faculty of a school organised for a science teacher educator (second author) with a background in PEEL (Project for the Enhancement of Effective Learning, Baird & Mitchell, 1985; Baird & Northfield, 1992) to be available to work with them in their classes at times which suited them. As part of this work, both the PEEL project and a Children’s Science approach to teaching and learning became better understood by faculty members. This resulted in one science teacher in particular (first author) becoming actively involved in developing ways of ensuring that students accepted more responsibility for their own learning.

Reconsidering existing teaching

The 30 girls and boys who comprised the Year 9 class which was the focus of this study attended nine 40 minute science classes per two week cycle, all except one was a double period. The existing Year 9 science course was generally structured as individual units of work. The students had a booklet comprising worksheets and most of the information (theory and practical) that they needed for the unit.

The original Electricity Unit was more practically based than most of the other units the students had completed (Atoms and Molecules; Science and the Road; Body Balance; and Ecology). It was designed around introducing the students to circuits. As the unit progressed the circuits became more complex. One of the concerns with the format of the unit was that although the worksheets appeared adequate, there was no sense of conviction in the teacher’s mind that the students’ learning about electricity was being enhanced. The students followed the instructions but did not seem to be particularly engaged by the work; that “Aha, I get it now” type of response was lacking.
In essence, although the curriculum was well organised and structured, the students had become comfortable with a format which more often than not led them to think and act routinely rather than in a deliberate and purposeful manner.

Fostering student interest in a topic is important, especially while introducing a new topic. Paying attention to, and valuing students’ input and ideas is one way of doing this. The intention for the teaching in this unit was to use probes (taken from Osborne & Freyburg, 1985) to “unpack” the students’ understanding of electricity. By using these probes as a starting point, it was inevitable that the unit would become student-centred rather than teacher dominated. If the students’ interests, concerns and questions were to be taken seriously, then they had to be used to drive the unit. Their “need to know” would determine what would happen next. Lesson preparation would take on new significance, the teacher would have less control of the content sequence in lesson planning, but a much greater demand would be placed on the teacher’s ability to match activities to the students’ expressed need to know. A natural consequence of working from the students’ concerns was the replacing of the worksheets. The aim of the unit was for students to learn by their own “need to know.” Students used to using worksheets are aware that the answers to problems and what to do next can be found on the worksheets. Worksheets could therefore hinder the students’ own need to know, as they would take their cues from the worksheets rather than as a response to their own thoughts and ideas.

The use of teacher generated notes on the chalkboard following each investigation was also seen as inappropriate, as it would cause a reliance by the students on the teacher. This led to the idea of using a logbook as a means by which the students could record their own progress through the unit.

**Using logbooks**

In the logbook students were expected to record all of their observations, document their results, write their questions, develop their hypotheses and conclusions, and generally develop their understanding of the unit. It is important to stress that the aim of the logbook was not solely to replace teacher generated worksheets with student generated worksheets. Some teacher generated worksheets were used where “a piece of theory” was needed for the students’ investigations to continue. Examples included the use and function of the ammeter and the voltmeter. The logbooks were to be used to record every investigation and the questions raised in their minds during the investigations. Students were encouraged to record at the end of each entry what they had learnt that lesson, and what still puzzled them. As well as this, the logbook was to be used to document and describe in their own words new or unfamiliar terms in the form of a glossary.

The students’ logbooks were collected at the end of each lesson then distributed again at the start of the following lesson. The aim of this rather time consuming process was to encourage the students to document and think about their work during the lessons rather than writing up their ideas at a time distant from the experience. In writing up their thoughts, students had the opportunity to discuss investigations within small groups, sometimes including the teacher. There was also a whole class debriefing in which all students had the opportunity to share their results and ideas with each other. It was anticipated that this would encourage the students to think more carefully about what they were doing during a lesson as they were largely responsible for constructing their own notes. Also, knowing that their questions might be used to direct the learning in the next session, it was hoped that this would encourage free and honest questioning of concepts, and shed light on misunderstandings, in ways that were perhaps less likely in a teacher directed class.

The logbook entries were so interesting and revealing that the original notion of pursuing eight or so after each class soon grew to reading all of them. It was also apparent that through the logbooks many students were able to safely raise their concerns about not understanding the work. This was particularly important for those students who felt uncomfortable about verbalising their understanding in class debriefings.

**Log Books: catalyst for thinking**

The use of probes was a very important means by which the concepts already held by students on many aspects of electricity were able to be “unpacked.” The intention of the probes was to stimulate the students to explore their understanding of, and need to resolve, content dilemmas. Probes used in the first few lessons came from Osborne and Freyburg (1985). Those used in later lessons were devised by the teacher (first author). Through both classroom experiences and the students’ logbooks it soon became obvious that the production and use of probes involved the development of new pedagogical skills. Probes which were well written encouraged useful student enquiry, poorly structured probes added to student misunderstandings. As an unexpected advantage, the use of logbooks therefore aided in the development of new pedagogical
approaches, but it was through the open and honest questioning by the students that the logbooks really demonstrated their value by enhancing students’ learning strategies. The following examples demonstrate this point.

**Logbook A:** (referring to a probe from Osborne & Freyburg, 1985)

From experimenting with the (am)eters, I found that

A—is wrong
C—is wrong
D—is wrong

but I’m still confused about B. If the electricity current in the wires both go towards the bulb, then what happens to the electricity when it gets there? But, if the electricity flow is circular, then why is energy not being used up and current less like in C?

**Logbook B:** We found that all of the voltage supplied by the battery is used by the lamp, e.g., if the battery is 6V, the voltage will read 6V across the lamp.

**Logbooks C, D, E & F** (following group work activity and in response to “How do current and voltage change as the brightness of the lamp changes?”): If the light globe glows brighter, that means that there is more energy and more current in the circuit.

The questions they then wrote though were very interesting.

How does the battery know to send more energy?

What happens when we put in another light?

Clearly these examples, which are indicative of the group as a whole, demonstrate the value of logbooks as a way of genuinely accessing students’ thinking. Consequently, the possibility for the teacher to address students’ misconceptions or to work through particularly demanding conceptual principles in appropriate ways is enhanced. Also, through the various forms of dialogue between teacher and student, in the logbook and in the classroom, students’ metacognitive skills can be developed. Purposeful questioning in the quest for understanding can be recognised and rewarded both at the individual and the classroom level.

**Overview**

The impact of logbooks as a learning device was interesting. The students’ questions were the catalyst for many of the class’ activities and they appeared to be using their logbooks in a responsible manner. For some students they were a very useful learning tool, for others they were undervalued. This was mainly because not all students had the discipline (or desire) to record what they had done and learnt during a lesson. This was perhaps more a reflection on the teaching practices normally experienced than on the students themselves. Too many classes are still run along the traditional lines of the student being told what to think, what to do and what to write. It should therefore not be a surprise that when presented with a situation in which what they write is their responsibility that some find it difficult to make the transition.

The use of a logbook calls for particular learning skills which need to be addressed by both students and teachers so that they become a more acceptable and useful resource. Logbooks would be difficult to use if students are used to, or expect, the teacher to do the thinking for them. Teachers need to develop an atmosphere where reflection on practice and an interest in everybody’s ideas is the norm. Highlighting the use and value of metacognitive skills is important if students are to overcome the initial difficulties associated with organising their thoughts in a meaningful way on paper. Such skills can be developed through the use of techniques such as: telegrams—students write a sentence or two at the end of a lesson saying what they have learnt, or what still puzzles them; listing what I know about a topic—from a list of concepts/content taught, students comment on those they believe they have learnt/not learnt, the list can be teacher generated, student generated or both. These techniques help student learn how to record their thoughts and reflections. Once these skills have been initiated, students’ confidence in recording their thinking using a logbook can be continually encouraged.

After an investigation to look at energy in a circuit, and having already explored current, one student constructed a drawing and explained it, another developed an analogy, as the following demonstrates.

**Student A:** My drawing shows that there is current running through both wires (arrows) and the current remains the same throughout the circuit. With this current is carried energy (dots). When the energy comes to the globe it is changed into light energy and you see the globe light. The current goes back to the
battery to pick up more energy to take to the light.

Student B: The current is like a delivery boy who collects his energy, takes it to the light where it gets used and then he goes back to the battery for more energy and he does this repeatedly.

A number of the students who had not coped well with the worksheets in previous units were very taken by the logbook as a means of recording their work. Their understanding of the value of the use of log books was borne out by the fact that the majority of students did not feel that the logbook was appropriate for all topics. Many of the students could see that log books were useful as a communication tool with their teacher for their individual and small group based inquiries, but not all fully grasped the notion or saw the value in writing about their thinking and learning. However, they certainly noted that if a unit was more teacher centred, then a logbook was not as important to them because “the teacher would give them the right answer anyway; so why bother trying to work it out for oneself?”

From previous experience in teaching this particular unit the teacher considered that there was significant numbers of students who were disenfranchised by the topic. This was particularly the case for the girls. It was therefore interesting to observe how the use of logbooks allowed students to really take control of their own learning. The girls in particular were very enthusiastic. They proved to be very good at conducting their investigations, discussing results in both small and large groups, and documenting their thinking. A number of the girls came to have a significant input in the direction of their own learning and that of their peers as their questions were the catalyst for the teaching and learning in many lessons.

Conclusion

The students enjoyed learning in an environment where they had control over their learning. Many lessons seemed to instigate that `aha` response from students, perhaps illustrating how this particular approach to the topic had addressed and answered their questions. In the first four weeks of the unit in particular, the meaning of terms used outside the science classroom became better understood as they were introduced at appropriate times and in appropriate ways, rather than being thrust upon the students as purely propositional knowledge. Learning was seen to be valuable as it gave answers to questions posed as a result of reflection on the students’ everyday experience. A good example of this followed the investigations on current and voltage, and how the two changed in the two wires in the circuit used in the laboratory. A number of students then wanted to know how the electrical appliances they were familiar with only had one lead going to them. For a number of students the operation of this unit was really tapping into skills they did not know they had; metacognition.

For students to accept more responsibility for their own learning it is important that they be successful learners. Through the use of logbooks this success is able to be fostered as their understanding can be used to help shape the teaching experiences. Learning is also enhanced when the purpose for an activity is clearly understood by the learner. It is therefore important that this be explicit for the students, and can certainly be developed by the individuals through their logbooks, so that they are fully cognisant of the purpose of activities and that they can make informed decisions about their own actions (or inaction).

Perhaps one of the most telling lessons from this experience is that if students are to be more responsible for their learning, they need to value the learning experiences that they are confronted by. This is not a simple process, nor is it a quick process. However, if students are given the opportunity to explore their understanding of content in appropriate ways they are more likely to value the experiences. Despite the students’ apparent control of content in this instance, the content covered by them almost exactly matched that required by the curriculum for Year 9 science.

For many teachers it is often the case that there is an implicit need to be responsible for what their students learn. Therefore, if students are to be encouraged to accept more responsibility for their own learning then they need to value their learning, this happens best when the teacher’s practice matches the teacher’s beliefs. The use of logbooks is one concrete way of encouraging this.

For the teacher of these students, there was no doubt that through the logbook approach the students were more actively engaged in their own learning in comparison to previous groups. There has also certainly been an increased understanding of his own pedagogical approaches and the reasons that underpin them.
References


Biography

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Cybercheck

This is a new journal for senior students and teachers. The emphasis is on science and society and, as such, is complementary to the ICASE/UNESCO initiative Project 2000+, scientific and technological literacy for all.

The journal will be published bi-monthly in printed form, but will be available also on 3.5 inch diskettes and through e-mail. Annual subscription is 50 pounds for the printed version, 60 pounds for electronic version. The first issue of the Journal has 40 pages.

A specimen copy of the new Journal has already been distributed to all members of ICASE. Individual subscribers to the ICASE Journal may obtain a sample copy by contacting the editorial office at Viale Aguggari 12, 21100 Varese, Italy (Fax: 39 332 236 997; E-mail: 100707.3432@compuserve.com)
Australian Joint Regional GASAT and IOSTE Conference

The international organisations Gender and Science and Technology (GASAT) and the International Organisation for Science and Technology Education (IOSTE) are holding a joint regional conference on December 5-8, 1997 at Curtin University's main campus in Bentley Western Australia.

Internationally, Dr. Jayshree Mehta is the president of both GASAT and IOSTE. It is, therefore, an opportune time for a joint regional meeting which will include the interests of both organisations and particularly the gender dimension of science and technology education.

GASAT

The aims of the international Gender and Science and Technology association are to:

- encourage research into all aspects of gender differentiation in science and technology education and employment;
- foster gender equality in science and technology education;
- foster socially-responsible and gender-inclusive science and technology;
- facilitate the employment of women into the fields of science and technology;
- provide a forum for dissemination and discussion of research and experiences of those working in the field;
- provide a support network for those working towards the objectives outlined.

Papers are invited that address any of these aims.

IOSTE

The International Organisation for Science and Technology Education was established to advance the cause of education in science and technology as a vital part of the general education of the peoples of all countries and to provide scholarly exchange and discussion in the field of science and technology education.

Papers are invited that have any of the following foci:

- alternative modes of delivery of science and technology;
- teacher education in science and technology that recognises and includes alternative modes of delivery;
- staff development for science and technology education;
- research in the teaching and learning of science and technology.

This conference will bring together a wide range of practitioners and researchers working in the areas of gender, science and technology education. Expressions of interest in attending and/or presenting a paper are called for. Flexible modes of presentation are encouraged. Abstracts and early bird registrations are due August 31, 1997.

Further details can be obtained from:

Joanne Goodell  Phone: 61 8 9266 2113
Teaching Learning Group  Fax: 61 8 9266 3051
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GPO Box U1987  web site available end of June
Perth Western Australia 6845  http://www.curtin.edu.au/conference/GASAT-IOSTE
Australia
COOPERATIVE GROUP STRATEGY APPLIED TO ACTIVITIES
IN A POLYMER CHEMISTRY CLASS

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MEXICO

Polymer Chemistry is a subject in the Chemistry Programs, students have a natural curiosity about Polymers materials, the materials that we all use in our everyday activities, such as poly(ethylene), PE, poly(styrene), PS, poly(amide)s are well known by the group and they are highly interested in their identification, production, characterization and peculiar properties.

Since there is a well spread misinformation about the contamination caused by polymers, we decided to clarify this point and emphasize in our classes, the beneficial aspects of the appropriate use of polymer in our community, so we thought that was important to test the cooperative group strategy in a polymer class with the main aim of improving the preparation of the chemical engineers in this topic.

The principal purposes of this project were:

1. To facilitate the study of the polymers science at undergraduate level.
2. To make the study of polymers more meaningful and close related to our everyday life activities.
3. To raise consciousness about the origin of raw materials used for the production of polymers, their chemical transformation and the necessity to recycle the polymeric product in order to maintain ecological equilibrium.
4. To discuss the economical implications of the great demand and consumption of polymeric articles.

Cooperative group strategy may be used to supplement other teaching methods. It involves students in small-group learning activities that promote positive interaction resulting in improved learning. In this cooperative learning, small heterogeneous groups of students work together to achieve individual and group objectives. The objectives may include both content and process skill outcomes. Additionally, by using well-defined roles, under the supervision of the teacher, students can develop social interaction skills.

As a result of its application cooperative learning produces positive effects on students who participate in it. In the affective domain, the strategy improves intergroup relationships among gender and stimulates the integration of social ethnic groups between normal and exceptional students (Slavin, 1991; Johnson, 1989; Kurfman, 1991).

The cooperative learning refers to a process in which the students working together in small groups, using social skills achieve academic objectives (Johnson, 1990; Kurfman, 1991). In this process the students realize that in order to reach their academic goals, the other students in the same group must also meet their goals (Slavin, 1990). This active participation enables students to practice interpersonal skills while they are achieving academic objectives.

Many studies (Johnson, 1989; Steinbrink, 1991) have shown that compared to other formats, cooperative attitude produces positive result in several domains. Researches (Jones & Steinbrink, 1988; Steinbrink, 1990) reported that higher achievement in their classes was observed when task in cognitive domain were
conceptually oriented. This orientation required problem solving and creativity, it involved higher level of the cognitive skills, and required the application of information to the real world.

According to other authors (National Council for Social Studies: NCSS, 1991; Steinbrink, 1990; Steinbrink, 1991), cooperative lessons should incorporate five essential components, those were incorporated during the development of our course.

As Steinbrink said, "the key to achieving positive results in cooperative activities is to divide the class in small heterogeneous groups, to develop specific task for each student in the group to perform, and to integrate these tasks into a teaching-learning sequence" (Steinbrink, 1991). For classes structured into group of four students, for example, the teacher would assign each group member one of the following roles: principal investigator, materials manager, the recorder-reporter investigator and maintenance director. Roles can be combined or divided as group size dictates. Stimulated by the positive literature reports in cooperative groups strategy we decided to use it, in a senior polymer chemistry class offered at the Facultad de Química of the National University of Mexico UNAM, in Mexico City.

**Methodology**

We methodology applied the cooperative group strategy to a class of 30 students enrolled in the Polymer Chemistry course that is offered every semester in the chemical engineering program. During sixteen week the polymer chemistry class met twice a week in a two hour session, along the semester. After a complete explanation of the cooperative group strategy (CGS), we asked the students to organize themselves in cooperative groups of the three, so a total of ten groups participated in this activities.

During the first week of the semester the instructor explained to the class the specific objectives of our project, these can be summarized as follows:

- To identify the origin of the raw materials used for industrial synthesis of the polymers.
- To become acquainted with the most important industrial processes used for the synthesis of polymers.
- To identify the most important variables related with the control of the polymerization process.
- To correlate the physical chemical properties of polymers with the final applications of this materials.
- To recognize the importance of the polymer's marked characteristics, the supply and demand.
- To evaluate the importance of polymers recycling.

The groups' first decision was concerned with the selection of a polymeric material that became important for a study, some of these materials are very familiar to the student since they are used in our daily community lives. Example of these polymers are: poly(ethylene) HDPE, poly(styrene) PS, poly(vinyl chloride) PVC, silicones, etc. Ten commercial polymers were chosen, see Figure 1.

**Figure 1.**

![Polymer Family Diagram](image)

In Figure 2, we try to emphasize the separation between the technical factors from the economic factors in our study. In the second session of the semester a list of the principal activities concern with the cooperative group were discussed with the class. We emphasized the importance of literature search, since no productive work can be initiated without a good knowledge of the state or the science for that subject, see Figure 3.
When the purification of the raw materials, the origin and quality characteristics are well understood, then the engineer is in a good position to undertake control of the production process. Once the monomers were purified and identified by means of spectroscopic test (IR, NMR, RI). The group synthesized the polymer. Activities such as literature search, monomer purification, polymer synthesis, characterization and identification, samples collection, final report and poster preparation were programmed along the semester on order to achieve the goals.

After the seventh week of the semester, the group concentrated attention in the search of several items fabricated with the material of study. Collection of five or more articles made of polymers were integrated. In order to facilitate this acquisition and to confirm the multiple application of polymers, the search was oriented principally around the house, the school and the office, articles used in our daily life activities, as examples we can mention: gears (PTFE), tooth brush (ABS), coffee cups (PS), decoration sculptures (PMMA), tires (NR). At the same time the students were involved in samples shopping, around one pound of ships of the polymeric material was collected. The samples and properties sheets were obtained through the local offices or large commercial producers.

Meanwhile we covered the topics of the current program in our regular sessions.

During the 14th week, the group became involved in the preparation of the final report. In the paper they included all the outstanding information gotten in the former activities. The information was concentrated on the form of: monomer and the polymer properties tables, polymeric reaction conditions and mechanism. Great importance was given to the selection of the appropriate polymerization technic. Engineering aspects of the reaction as the kinetic equation and type of reactor recommended were analyzed and asked to be included in the report.

In most cases the core of the paper was dedicated to the description and variables analysis of the industrial polymerization process. Questions concerned with the type of reactor and equipment required to separate and purify the polymer were analyzed.

The polymeric materials studied were classified according with their main application in five traditional families: engineering plastics, fibers, coating, elastomers and adhesives. The figures describing the consumption tendencies and the relation production-consumption were included. The principal national and international material's producers were identified.

One section of the report was dedicated to the presentation of examples of the practical uses for each polymer, pictures of items were included, most of the groups were oriented to the presentation of some spectacular applications, as the medical, aerospacial and telesat. See Figures 3 and 4.
The class decided to share this experience with the rest of the college community, so we organized a poster display in the main floor of building “B,” entrance hall of Facultad de Química UNAM. This place is frequently visited by the students and is the natural meeting place for our classes.

In a democratic way the class decided to call this event EXPO-POLYMERS. The class was organized in groups of six members. Each group had a special assignment. One group was appointed by the professor to the preparation of the show place, engineering activities concern with the electrical power supply, lights and general services. Another group was charged with painting and grooming the show area. A third group took the responsibility of preparing invitations and programs for faculty members, families and friends. One group suggested to have guided tours around the exposition, in order to present and discuss the information in a well documented manner, in this group each aide worked with a small group of five persons for periods of 30 minutes, the necessary time to go over the display. Another group was assigned to produce information about the event for the media, college newspaper articles. Colleges TV. One video with the most relevant moments of the opening session was prepared. The opening ceremony was attended by graduate studies dean and a large group of faculty members from the Chemistry and Engineering Departments. See Figure 5.

Conclusions

During sixteen weeks of the semester the class was very active. The cooperative spirit of the group was very high, this environment facilitated the communication with the professors, among the groups and in the groups. As a result we can say that our objectives were reached in a very productive way.

A more positive affective relationship among students and between students and faculty has been observed in the group, these concepts were shared by the classes working with cooperative strategy, as a result, a more positive psychological well being, greater self-esteem, self-sufficiency, social skills, coping skills, and general psychological health, was developed in the class.

The students comments were very favorable to the project. This was a life time experience that we want to share with others.

Figure 5.
Reference


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**SCIENCE & SOCIETY: TECHNOLOGICAL TURN**

*International Conference on STS, Japan*

*March 1998*

Topics include the following:

- Network Assessment of Science
- Transnationalization of Corporate Science
- Science and Technology in Asia
- MITI and Innovation Policy
- Cultural Studies
- Gender
- Social Epistemology of Science
- Implication of STS on Science Education
- Human Resource
- Knowledge Production Mode 2
- Technology and Media
- Japanese Studies on STS
- Post-Colonial Studies
- Expertisation and Public Awareness
- Medicine
- Religion and Science
- Science Education Policy
- International Relation in the Post-Nuclear Age

Invited speakers include the following:

- Michel Callon
- Deepak Kumar
- Brian Martin
- Rustum Roy
- Peter Weingart
- Sheila Jasanoff
- Morris Low
- Arie Rip
- Song Sang-Youg
- Robert Yager

To obtain the first circular or more information, please contact:

Conference Office
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E-mail: sts@kob.is.uec.ac.jp

WWW homepage: http://hostcinf.shinshu-u.ac.jp/stsconfjp.html
REGIONAL GUIDELINES AND PRELIMINARY TIME LINES

Step 1 June–July 1997

Regionalizing or nationalizing project material, for example possible translation, addition of local reply address, etc.

Step 2 August–September 1997

Copying and distributing the adapted brochure to all members of ICASE in the region and as widely as possible to any other interested people, schools, or education offices.

Step 3 September 1997–Early 1998

Encouraging and collecting as many names and addresses as possible of schools wishing to take part in the links scheme. Making a regional list or data base of the schools interested in joining the international science links scheme.

Step 4 Early 1998

Send to all interested parties or schools in your region who request links a Key Information Sheet and reply letter.

Step 5 April–June 1998

The ICASE Regional lists of those wishing to participate need to be centralized, matched and the links made. Executive Secretary, Jack Holbrook has offered to do this amalgamating of the lists and data bases.

Step 6 Any time after the link is made

Schools and links will forge ahead.

Step 7 Towards the end of 1999

Information from linked groups wishing to share their international Links Science/Technology Project would need to be collected, certificates issued, and the possible means of sharing the experiences carried out (for example possible exhibitions, news letters, posters, booklets).
Editor's Introduction

Across the world attention is shifting from pre-service teacher education within the confines of the college or university to the crucial phase of induction, the first year(s) of teaching when the teaching novice grows into the profession. Student teachers often complain about the irrelevance of pre-service education, teacher educators complain that in pre-service one can only teach survival skills and that students are not ready for more sophisticated teaching skills and methods until they have taught at least a year and then they are out of reach of the teacher educator as they have graduated. That is one of the reasons that pre-service teacher education itself is shifting from colleges to the schools. In UK pre-service students spend most of their time in the schools and their mentors (cooperating teachers) are their teachers more than their college advisors. Induction programs assist teachers in their first year(s) of teaching and try to put them on the track of life-long professional development (see Poul Klindt’s article about the Lesotho induction program in ICASE Science Education International of June 1994). Below Herbert Thier describes a comprehensive project on the West Coast of the U.S.A. In a later article he hopes to give information about first experiences.

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The goal of this project is for beginning teachers to experience student teaching and the early years of teaching as the beginning of a long term growth and learning experience. For this to happen, we must change the way teachers are prepared for and function in tomorrow’s classrooms. The focus in this project will be the teaching and learning of science as an exemplar of an overall approach to more effective teaching in the elementary school. This project will be a cooperative effort between the Science Education for Public Understanding Program (SEPUP), developers of CHEM at the Lawrence Hall of Science, University of California at Berkeley, and the Institute for Educational Inquiry (IEI) of Seattle, Washington and its associated Center for Educational Renewal (CER) at the University of Washington. Overall responsibility for the design and implementation of the project will be the responsibility of Dr. Herbert D. Thier, Director of SEPUP, and his staff. Dr. John Goodlad, President of IEI, and his staff will be responsible for cooperatively designing field test models and helping to implement field testing of the project in five of its National Network for Educational Renewal (NNER) settings, and five additional sites to be chosen.

SEPUP/CHEM will provide the instructional materials to be used in the classroom by the participating teachers and will design, develop, and produce the materials and models for using them, which will be used by teacher educators in their work with pre- and in-service teachers. The cooperation of the IEI/CER and its associated National Network for Educational Renewal will provide the project with extensive input on models and approaches for using the instructional materials to be developed. In addition, this cooperative effort will permit the materials to be used at selected NNER sites. These sites are involved in a major national effort to establish new teacher education programs based on institutional commitment at all levels, including the full participation of education and arts and science faculty and deans plus the teachers and administrators from partner schools. These NNER sites are currently developing instructional materials and developing and
establishing pedagogic practices, particularly those related to the supervision of student teaching and associated experiences for future teachers.

**Project Goals and Objectives**

**Goals**

The goals of the Elementary Science Teacher Leadership project are:

1. Design, field test, and produce science teacher education materials (the ESTL guides) and approaches for using them that will contribute to improving the quality of elementary science teaching in the United States.

2. Further design, make available, and help put into practice cooperative models for including such materials in the wide variety of organized pre- and in-service elementary teacher development programs currently under way or planned in the United States.

3. Collaborate with professional groups such as the National Science Teachers Association (NSTA), the Association for the Education of Teachers in Science (AETS), and others to design and offer a series of Exxon Elementary Science Teaching Institutes. Institute participants will include university professors, school system leaders, and others responsible for designing and implementing elementary teacher development programs at the local level.

**Selected Objectives**

1. Select topics, format, and suggested models for the Elementary Science Teaching Leadership (ESTL) guides that will be developed by the project for use by elementary science educators.

2. Design, pilot, collect feedback on and revise two sets of five ESTL guides and suggested ways of using them as part of an overall approach to improving the ability of pre- and in-service elementary teachers to teach science and use science to more effectively accomplish their overall instructional goals for their classes.

3. Carry out national field tests of each set of five ESTL guides in conjunction with five selected IEI/CER/NNER sites and five other sites that include school systems participating in the Issue-Oriented Elementary Science Leadership (IOESL) Project.

4. Prepare all ten ESTL guides and the suggested models for using them for final publication, incorporating feedback, assessment results, and independent expert reviews. This will be done cooperatively with the ESTL Panel and the input from the IEI associates involved in the project.

5. In cooperation with the ESTL Panel and representatives of selected professional organizations design a seminar program for introducing teacher educators to the ESTL guides and their use in pre- and in-service elementary teacher education programs.

6. Conduct and collect feedback on a pilot Exxon Elementary Science Teaching Institute in Berkeley during the summer or fall of 1999.

7. Field test the project approach to developing elementary science teaching leadership by conducting three Exxon Elementary Science Teaching Institutes during the 1999-2000 academic year.

8. Use further feedback and evaluation of both the modules and the institutes to develop a long-term plan for offering the institute and for providing attendees with the ESTL guides and other project materials needed to effectively utilize the modules in their own teacher education programs.

**Please Note:** The editor would like to remind our member organizations and individual readers that all articles in Science Education International are available for reprint in your own journals. All copyrights are extended to members. This is a wonderful opportunity. Please consider starting an international section for your journal and use our fine articles to expand global awareness. All we ask is that you give credit to the author and the ICASE Journal.
PROMOTION FOR THE TEACHING PROFESSION

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In many countries teaching has lost its glamour and teacher shortages have surfaced in science and even more so in a field like Physics. In some (not all) industrialized countries the glamour has gone due to more serious classroom discipline problems than before and salaries which have become less competitive. Even students from teacher colleges no longer become teachers automatically. In the 1980s many science teaching graduates in the Netherlands became teachers of computer courses in industry and business rather than school teachers. In many countries teacher colleges became polytechnics or universities. In developing countries the emergence of mass education (positive) has created a huge group of teachers and made salary increases or even compensation for inflation very difficult for governments. In many African countries teacher salaries have dropped considerably. Where before the leaders of independence and national heroes had been teachers (Julius Nyerere, former president of Tanzania; Kenneth Kaunda, former president of Zambia; others), now their sons and daughters would become anything but teachers. In quite a few countries corruption in the huge national Departments of Education has made classroom teachers particularly vulnerable and powerless. The result has been that only weaker and/or poorly prepared students go into teacher education leading to a considerable drop in competence. It should be emphasized that trends as described here are often cyclical, but with very long cycles. For example, complaints about the talents of recent teaching graduates might lead to higher salaries and then to higher status of teachers which might attract better students.

When designing our science teacher education project in the Philippines over two years ago, we (Philippine and Dutch colleagues) opted for prioritizing pre-service teacher education over in-service. For many years the production of teachers had been much less than replacement and expansion needs and many unprepared teachers had entered the profession somehow. For example, 90% of the Physics teachers and 80% of the Chemistry teachers in the Philippines are considered not qualified in their subject. Most Physics and Chemistry teachers come from other subjects such as Mathematics, Agriculture, and Physical Education and have been forced to teach Physics or Chemistry. We wanted to attract bright students into a profession that more and more only attracted weak students. Our Philippine colleagues believed that a promotion campaign and scholarships would do the job. We had some doubts whether that would be sufficient but they were right. We have had a promotion campaign for two years and about 35 scholarships each year and we have been able to attract 35 good students last year and another 35 this year. Among them are valedictorians (best students in their graduating class) and quite a few (about 30%) honor students who placed 2nd, 3rd, or 4th in their graduating class. For many students the scholarships are the only way to get into higher education, the scholarships contribute to upward mobility. In interviews these students have been able to convince us that they are really interested in teaching and not just in the scholarship. We will see how their motivation develops. However, there are also children of the middle class. Their parents consider teaching as a sure job while other professions (even engineering) have many unemployed.

Promotion campaigns have to work differently in different countries. In the box I included a sketch of our Philippine sales pitch and it has worked very well. In the early 1980s in Indonesia there was a scholarship scheme to overcome the shortage of science teachers. All over the country 1, 2, and 3 year Diploma programs were started with guaranteed placement as a teacher upon graduation. A new group of students entered college, those who could not afford a regular college program, but whose families dared to invest in a two year program with a guaranteed job at the end. We were able to select students from four times more applicants than we could accept. Nationally the program fared less well due to poor quality teaching and lack of quality control, but the programs did attract enough students. When later the worst teacher shortages were alleviated and government jobs upon graduation became a problem, the number of applicants quickly decreased. At present there is a serious oversupply of teachers in some heavily populated provinces in Indonesia. Yet
these experiences do show that in developing countries the proper incentives can generate a stream of good applicants for teacher education programs. Scholarships can do the job.

In the past Dutch students in university programs could take a bit of extra load for several semesters and get certified as teachers for the upper academic levels in high school. In the mid 1980s the system changed and required an extra year of study. Furthermore, education budget cuts were achieved by cutting salaries of beginning teachers and sparing the older and highly paid teachers. These older teachers had been hired in the 1960s at relatively high salaries when the economy was booming and participation in secondary education expanded rapidly. The low starting salaries were bad publicity for the profession. For several years no students entered physics teacher education. Then when the government offered graduates of selected science subjects (Math, Chemistry, Physics) half-time teaching jobs with full-time pay and paid for teacher training, students were coming although not in great numbers. The scheme had to be discontinued due to cost. Teacher colleges constitute another component of teacher education in the Netherlands. They educate teachers for junior secondary teaching. The colleges have tried all sorts of campaigns to attract students, but particularly in Physics and Chemistry, they have not been successful.

The status of the profession has been undermined by budget cuts and widely published classroom discipline problems. As elsewhere (e.g. Australia, UK), the Dutch teacher colleges have merged with other forms of higher education and have become polytechnics or 2nd tier universities.

What do we learn from this story? That the proper mix of incentives can attract good students into science/math teacher education but one does need the proper selection instruments and policies as well as a good educational program to realise the benefits of potentially good students. Also in industrial countries governments can “play” with the mix of incentives and disincentives, but it is more difficult to compete with well paying alternative employment and students are less “influenceable.”

Note to Member Organizations

Please ask your members to submit material to Science Education International. We are looking for:
• Teaching activities and lessons, especially for elementary
• Action research articles which talk to the practicing teacher
• Research articles which focus on practice, not research strategies
• Informal and nonformal articles which address “Things to do” in these settings

PLEASE INCLUDE PICTURES AND OTHER DRAWINGS OR GRAPHS.
Manuscripts may be sent to:
Ronald J. Bonnstetter, Editor
ICASE Journal
University of Nebraska
211 Hennzlik Hall
Lincoln, NE 68588-0355
USA
A PROMOTION CAMPAIGN

First we pushed the car with driver to the nearest gas station. Apparently he ran out of gas and money and had reached us on the last drop. Then we drove for 12 hours over a slow road with a lot of traffic until we arrived at a small (330 students) Catholic High School. The purpose of the trip was to advertise our teacher education and other science programs.

You cannot become mayor, big businessman, or President of the country without teachers! Even Jesus chose to be a teacher. This is how my Filipino colleague Malou Gallos started her speech to the students. The teacher profession has had a low status for some time. That is why it seemed necessary to use religious and secular heroes in the promotion. Some other golden statements: The most beautiful and handsome in the professions are teachers, because they have a two month vacation to rest and beautify themselves. Which other employer in the Philippines offers a two month paid vacation? (About 80-90% of the science and math teachers are women.) My colleague does not mention that most female teachers have families and perhaps just like herself do the laundry at 4:00 a.m. and the ironing and 22:00 p.m. However, the Filipino High School students react much less skeptical than Dutch students would have, but they certainly know that teaching is a lot of work for a limited salary.

Is being a teacher hard and tiring? Yes, shouts the class. Can you become a millionaire by teaching? No, shouts the class. Do you know that teachers have long and paid vacations? No, they did not seem to know. Do you know that the teacher does not only earn P2000 or 3000 but P7000 ($260/month)? Look at Mrs. Reyes (the chemistry teacher of the school), does she look poor? No, not quite, they seem to think. And I? No. And look at Dr. Ed, is he poor? No, shouts the class. One can read in their expressive faces: Such a foreigner with a fat salary . . . But he is a teacher, so becoming a teacher cannot be too bad. Who has parents who are teachers? Now, several students have. Well, they had the money to put you to school in this school!

We have been to many schools with her speech and my demonstrations. Now we have 35 students for the Physics/Chemistry pre-service teacher education program and we have been able to select from more than three times that number. All students have a scholarship, one half from the Philippines government, the other half from our project. All students have passed their first semester courses without major problems. The promotion campaign also resulted in about 60 new students for the regular Physics program (PDP project) while the annual intake had been two or three students for the last 15 years. This year Malou Gallos and her colleague, Cheryl Yap, were able to get 2000 students to take the exams for Government Science and Technology scholarships. Some of these students will come to our programs, others will go into engineering. Our challenge now is to offer these students good programs.
Calendar
1997-1999

June 21-24, 1997
International History, Philosophy and Science Teaching Group
North and South America Regional Conference
Calgary, Canada

A regional conference of the International History, Philosophy and Science Teaching Group will be held in June 21-24, 1997 at the University of Calgary, Calgary, Canada. The Dean of the Faculty of Education, Professor Ian Winchester, will be the conference chair. Although a regional conference, all members of the International Group, and others, are welcome to attend. Calgary is situated at the foot of the Canadian Rockies, near to the mountain resort of Banff. The conference programme will include an optional visit to the Rockies.

International and national groups that have interests in the role of HPS in science, mathematics and history teaching are encouraged to use the conference as an occasion to present their work and to consolidate networks.

Proposals for contributed papers, workshops, discussion groups, and exhibits of curricular and instructional materials related to the purposes of the conference are now being accepted. Four copies of the proposal or paper should be sent to Ms. Linda Lenz at the address below.

Proposals and papers should be sent to, and registration information can be obtained from:
Ms. Linda Lenz
Faculty of Education
University of Calgary
Calgary, Alberta
Canada, T2N 1N4
E-mail: hpsst@acs.ucalgary.ca

October 1-5, 1997
8th International Conference of ISATT (the International Study Association on Teacher Thinking)
Kiel, Germany

The Conference theme is “Teachers’ Work and Professional Development.” The work of teachers is changing due to systemwide policies, global economic and technical trends, equity issues and changes in the nature of school subjects. These trends place teachers in new roles. How do teachers respond? In times of change it is important to consider the implications for the individual, social and cultural development of the teaching profession. What now constitutes, “professional” development? What is the impact of research and curriculum development?

Registration fee will be 400 DM for nonmembers and 350 DM for ISATT members or students.

Information about the forthcoming conference are provided on the Internet:
http://www.ipn.uni-kiel.de/isatt

You may also contact:
Dr. Manfred Lang (chair Program Committee)
IPN, Olshausenstrabe 62
0-24098 Kiel, Germany
Tel/Fax: +431-880-3100
E-mail: langm@ipn.uni-kiel.de

July 19-July 4, 1997
CONASTA 46
Annual Meeting of the Australian Science Teachers Association
University of Melbourne

Science Down Under—Extending the Boundaries. Our aim is to provide science teachers with up-to-date cutting edge information on the thinking of Australian scientists and near neighbours. The programme will also highlight practice and theory suitable for all levels of science education. It is our intention to extend the boundaries of knowledge.

For more information contact:
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PO Box 190, Richmond, 3121
Tel.: (03) 9428 2633
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E-mail: stav@netspace.net.au
December 5-8, 1997
Australian Joint Regional GASAT and IOSTE Conference
Curtin University, Bentley, Western Australia

This conference will bring together a wide range of practitioners and researchers working in the areas of gender, science and technology education. Expressions of interest in attending and/or presenting a paper are called for. Flexible modes of presentation are encouraged. Abstracts and early bird registrations are due August 31, 1997.

For more information, please contact:
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March, 1998
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An International Conference on STS
Japan

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- Network assessment of science
- Transnationalization of Corporate Science
- Technology and Media
- International Relation in the Post-Nuclear Age
- Science and Technology in Asia
- Implication of STS on Science Education, Science Education Policy and Human Resource

Among the invited speakers are: Michel Callon, Sheila Jasanoff, Deepak Kumar, Morris Low, Brian Martin, Arie Rip, Rustam Roy, Song Sang-Youg, Peter Weingart, and Robert Yager.

For more information, please contact:
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c/o Prof Shin-ichi Kobayashi
Graduate School of Information Systems
University of Electro-communications
1-5-1, Chofugaoka
Chofu, Tokyo 182
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NSTA Conventions: (More details to come.)
April 16-19, 1998
National Convention in Las Vegas, Nevada

March 25-28, 1999
National Convention in Boston, Massachusetts

April 6-9, 2000
National Convention in Orlando, Florida

March 22-25, 2001
National Convention in St. Louis, Missouri

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The 11th ICASE Asian Symposium
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This journal provides a means for associations, institutions, centres, foundations, companies and individuals concerned with science education, to share perspectives, concerns, ideas, and information which will foster cooperative efforts to improve science education, and which will serve as a chronicle of the advancement of science education throughout the world.

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Dates for Receipt of Contributions

<table>
<thead>
<tr>
<th>Issue</th>
<th>Closing Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>March</td>
<td>1 February</td>
</tr>
<tr>
<td>June</td>
<td>1 May</td>
</tr>
<tr>
<td>September</td>
<td>1 August</td>
</tr>
<tr>
<td>December</td>
<td>1 November</td>
</tr>
</tbody>
</table>

ICASE News ..................................................... 2
Feature Article ............................................... 6
Science Education Around the World ............. 9
Research on Curriculum, Teaching, and Learning ................................................. 13
Teaching Materials and Strategies .......... 18
Science Teacher Education and Leadership .................................................. 24
Non-formal and In-formal Science Education ........................................... 31
Calendar ......................................................... 38

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ICASE News

This section provides news for the information of member associations, institutions, centres, foundations and companies. The Executive Committee encourages members to reproduce this section in journals and newsletters to communicate this information to as many as possible.

Workshops on Creating STL Teaching Materials—
Lahore, Pakistan 4-8th April and Mar del Plata,
Argentina 19-22nd April, 1997
by Jack Holbrook

ICASE, in conjunction with UNESCO and the local STAs, ran two STL (scientific and technological literacy for all) teacher writing workshops, one in Lahore, Pakistan and the other in Mar del Plata, Argentina. In these workshops, participants from regional STAs and other institutions were introduced to the Project 2000+ philosophy on science education and the need to make science teaching in schools more student-centred and more relevant for the students. Stress was placed on the need for change, but with this change first coming from the teacher in the classroom.

(Examples of this material is on the ICASE website: http://sunsite.anu.edu.au/icase)

In groups the participants were invited to create materials of their own. These are now being edited and will be trialed in the school situation. The participants judged the workshops to be very useful and the Project 2000+ philosophy worthy of further consideration.

It is hoped follow up to these workshops can take place and further regional workshops of this nature initiated. Participants for the regional workshops should be well placed to assist STAs run local workshops of a similar nature. ICASE will be very interested to hear from STAs willing to host such workshops. Please contact the ICASE executive secretary.

One approach suggested for helping change was the creation of supplementary STL teaching materials. First a number of exemplars were introduced and the participants interacted with these at length. All exemplary material met the STL criteria set:

1. Student participatory
2. Relevant to the local society
3. Motivational for the students
4. Educational - promotes higher order learning and societal/personal skills
5. Based on constructivist principles
6. Promotes communications skills
7. promotes cooperative learning

10th ICASE Asian Symposium

The 10th ICASE Asian symposium was held 5-10th April 1997 at the University of the Punjab, Lahore, Pakistan. Over 200 participants from Pakistan and other Asian countries participated in this symposium on "empowering teachers to promote scientific and technological literacy for all in the 21st century." It emphasised the need to help teachers change their views about science teaching and to review student involvement. It pointed out that students and teachers reading the textbook is definitely not science.
I was once told "anyone can organise a symposium in a developed country, but it is a real challenge to do this in a developing country." It is thus with great pleasure that I report the 10th ICASE Asian symposium was not only successfully held in Pakistan, but that it was away from the capital and upcountry in the number two city, Lahore. The more than 200 participants mainly from schools, colleges and training institutes came from all over Pakistan and representative attended from ICASE member organisations in a range of Asian countries, from Japan to Iran.

It is no small feat to organise a symposium in Asia where many countries are among the most populous and classified as developing. ICASE is thus proud to have held 10th such symposium in Asia, beginning with the very first in India in 1977 and culminating in the 10th anniversary 29 years later in 1997. And not only did the symposium attract science teachers from the primary and secondary levels, but it was the largest meeting to be held at the University of the Punjab (according to the Vice-Chancellor) for many years and certainly the only such meeting in Science Education.

So far perhaps this is report is nothing special. But allow me to paint a picture of science teaching in some Asian countries. Imagine a class of 70-150 students with virtually no apparatus, maybe no laboratory and certainly very few chemicals. The curriculum changes from time to time, but the teaching remains the same. The teacher needs to cover the textbook !!! The textbook is king. The examination questions come from the textbook and if they do not, the students refuse to sit the examination, claiming it is unfair. And teacher opportunities for training, certainly in-service retraining, is very minimal. No wonder teacher morale is low and teacher absences high. No wonder student drop out is very large.

Yet the symposium was able to bring together enthusiastic teachers, teachers willing to pay a registration of 300 Rupees (5-10% of monthly salary), to spend 2-3 hours travelling home afterwards and to attend a symposium in an international language (English) which is a second language for all and which is presented in a variety of accents. But they welcomed the plenary sessions, complaining they wanted more question time. Enjoyed the presentations and workshops, especially any related to experimental work. Many overseas participants from STAs in other Asian countries were willing to offer demonstrations of simple experimental ideas—reflection inside water or any medium made visible by smoke or colloidal particles, movement on water testing whether eggs are raw or hard boiled, pressure change caused by the expansion of a volatile liquid to fire a simple cannon, changes in vapour pressure using the drinking duck and so on.

But if ICASE can take pride in itself in lending its name to this symposium, it is the Pakistan Association for Science Education (PASE) and to its symposium
convenor in particular, Hafiz Muhammad Iqbal, that thanks are due for the tremendous efforts undertaken to overcome so many constraints and see the symposium through to fruition. Funding was always in short supply and it may not be surprising to hear that the total cost of mounting the event is much less than US$50000, inclusive of airfares for 12 overseas delegates, conference bags, programmes, proceedings and refreshments of all during the symposium. All this from a man described by the Vice-Chancellor of the University of the Punjab as "a small man, with a big heart and a large mind."

2nd ICASE Latin American Symposium

The 2nd ICASE Latin American symposium was held in Mar del Plata, Argentina from the 22-26th April 1997. This was an extremely well planned and executed symposium attended by approximately 500 participants covering most of the Latin American countries. It was also the first ICASE symposium to be held in Spanish and the first to have instantaneous translation for some of the keynote presentations. The meeting was held on the theme—to improve scientific and technological literacy for all: a challenge for the year 2000.

This symposium went a long way to promoting Project 2000—the ICASE/UNESCO initiative to mobilise efforts by Governments and non-Governmental organisations (e.g. STAs, Teacher Education Institutes, Curriculum Development Centres, Universities) to rethink the purpose of science education and, looking ahead, suggest the direction of science education for the next millennium for all students—academically able and students with learning difficulties, girls as well as boys, science as an integrated, interdisciplinary subject or science separated as biology, chemistry and physics, science in well stocked laboratories and science where the society resources are all that are available. Project 2000+ provides a particular challenge to science teacher associations and this symposium was a start to encouraging the formation of professional STAs in the Latin American countries.

The success of the symposium is in no small way due to the dedication and efforts of 3 ladies—Marta Moyano the symposium organiser, Gabriela Inigo and Vilma Giannini. ICASE is very grateful for their efforts and wishes to congratulate them on their success. They have set a very high standard for the 3rd Latin American symposium (being planned for Chile in 1999) to maintain.

1997 CEFIC Award Winners

Geneva, 13 June 1997—On the occasion of the CEFIC, European Chemical Industry Council, General Assembly in Geneva today, Mr. Jürgen Dormann, CEFIC President, presented the 1997 “CEFIC Science Education Award” to Ms. Mona Gidhagen and her class of students from Ytterbyskolan, Ytterby, Sweden.

The Winning Team was selected by an International Jury from among 41 finalists from 18 European Countries. The winning “Daily Chemistry” project consisted of a study of everyday items as varied as auto products, cosmetics, detergents, iron and steel, medicines, metal packaging, paint, pulp and paper, soap and shampoo, etc. It focused on how chemistry plays an integral part in our daily lives.

Mr. Gunnar Uhlin, Headmaster, received the "Science Award" and a check for 5000 ECU, on behalf of the school.
The winning teacher, Mrs. Mona Gidhagen received a check for 1000 ECU and the “Excellence in Science Education Award” Diploma.

The Second Prize went to Mrs. Ann de Neef and Mrs. Hilda Jonckers of the Sint Theresia College Kapelle-op-den-Bos, Belgium for the “Clean but Green” Detergents testing project.

Two Third Prizes were given to: Mrs. Jana Dudrova of Masarykova Stredni Skola Chemicka, Prague, Czech Republic for the “Tyre production, use and recovery” project; and to Mrs. Alina Jaworska-Mattylla of the Technical High School for Builders and Carpenters, Poznan, Poland for the “Food packaging in Poland before and after 1989” project.

1997 CEFIC Science Award Winners

Scientific Literacy—An International Symposium

From September 9 to 12, 1996, the IPN (Institute for Science Education, Kiel, Germany) held a symposium on Scientific Literacy in Hamburg. The meeting was intended to be a dialogue between German-speaking and British and Northern American scientists.

The IPN has published the proceedings of the symposium and presented them at the recent NARST meeting in Chicago.

For more detailed information with program, list of participants and all abstracts please visit our symposium’s website: http://www.ipn.uni-kiel.de/work_e/a4/allgemein.html

The volume is available from IPN for US$20. To order a copy please send an e-mail to Dr. Wolfgang Graeber (wgraeb@ipn.uni-kiel.de), we will then post a copy and an invoice.

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SCIENCE ACROSS EUROPE—WHY IT WORKS!

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Abstract

This paper gives a brief background to the development of the Science Across Europe (SAE) project and its aims. It investigates the elements which make the project innovative and different to related projects, as well as successful. Future developments are also discussed. The paper is relevant to teachers/advisers/trainers/inspectors and other school educators in the sciences, languages and humanities, including those with an interest in the use of the Internet in education.

Introduction

In response to the growing need for school educational materials in the 1980s, that focus on the applied nature of science, its relevance to society and in particular relation to the teenage community, a successful set of curriculum enhancing materials were developed in the UK, entitled Science and Technology in Society (SATIS). At an international forum during an Annual Meeting for the Association for Science Education, the possibility of developing these materials from their UK school base area was investigated—to bring a global dimension to education, for students to learn how people in different parts of Europe use science in their efforts to understand and solve crucial everyday issues—and so the project Science Across Europe was conceived in 1990.

From the beginning, Science Across Europe has evolved under the active partnership between the Association for Science Education and British Petroleum (BP), and it is this partnership that has been an integral factor in the success of the project.

Science Across Europe, with its resource materials, provides a forum for students to exchange facts and opinions of their own concern and interest with students in other countries and cultures. It is this exchange of information which makes the Science Across Europe project unique and stimulating to students.

The Aims and Objectives

Science Across Europe has developed the following overall aims from the beginning, as exemplified by Evelyn van Dyk (1996):

• to bring a global dimension to education by raising awareness of varying perspectives and ways of life of students in different countries;
• to raise awareness of the ways science and technology affect society, industry and the environment; and
• to provide opportunities for teachers and students to collaborate with those from other countries; and to develop communication skills, especially languages other than their own.

These aims have been categorised into socio-scientific, informative and affective education areas by Sinigalas and Turner (1997). They also fit into the pattern of changing emphasis in the classroom from teaching to student centred, hands-on learning, as indicated by Rutherford and Grana (1995) and the 1996 UNESCO report “Learning—the treasure within.” Educators find the project attractive as it fits current trends in education—science, the environment, languages and newer technologies (email and the Internet) all in one package. The Science Across the World web pages, the only global education web site in six languages were nominated as “Internet site of the month” in July 1997, by Access to Excellence in the USA. The project has also gained recognition by winning the Global Best Award in North America and the Aim High Innovation Award in the UK, both in 1996 for education and business linked partnerships.

The project encompasses the wider aspects of science and can be a useful means of teaching and assessing key skills, e.g. the "Drinking Water" unit has been used as the basis for the collection and processing of data for General National Vocational Qualifications (GNVQ) in the UK, under numeracy, communication and information technology (Taylor, 1997).

The project is recognised as a useful tool in gaining language skills, with the units written in at least 12 European languages. More than 50% teachers found an enhanced knowledge of other languages in their students (O'Rowe & Neill, 1996). The Association for Language Learners (ALL), working in consultation with SAE and the Centre for Information on Language Teaching and Research (CILT) has recently produced a guidance booklet (Language through Science) for language teachers using SAE materials. ALL aims to provide SAE training for language teachers in target European countries later in 1997 and 1998. This programme of training follows on from the successful SAE multinational in-service teacher training programme, which extended to more than 300 teachers, trainers and advisers from 15 European countries, under the European Union Comenius umbrella in 1996 and 1997.

The project provides materials for other positive cross-curricular links. Eighty-six percent of teachers found an increase in student knowledge of geography, 70% in "economic awareness" (O'Rowe & Neill, 1996).

The project can provide the basis and impetus for extended links and partnerships between schools. 30.2% of participating schools have developed additional collaborations, based on their initial contacts through SAE units (Sinigalias & Turner, 1997).

The number of schools in Europe has risen by 91% over the year 1995-6. At the time of writing, 489 schools are actively participating in the project from 22 European countries. There are 640 registered teachers undertaking 815 units; the most popular of which are "What did you Eat?" and "Drinking Water" accounting for 18.5% and 16.8% of the units purchased respectively. Eighty-six percent of teachers indicate that they are using or will use the materials again (Sinigalias & Turner, 1997).

An outline of the Units

The main method of achieving the aims in the European classroom is through a series of units, focusing mainly on environmental science topics. The topics, chosen for their application to school curricula, also fulfill the commitment of BP as a "responsible corporate citizen," as part of their international business strategy. The eight units available are: Acid Rain over Europe, Using Energy at Home, Renewable Energy, Drinking Water, What did You Eat? Global Warming, Domestic Waste and Road Safety; with Keeping Healthy ready for trials between February and April 1998. Schools wishing to participate in these trials should contact Science Across Europe before the end of January.

Each unit has been created at a specific writers workshop by a team of teacher writers from 15 European countries, together with BP Community Affairs personnel. It is this melange of experiences, cultures and expertise that is a key factor in the success of these materials. The following four elements to a unit must be satisfactorily completed before the unit is ready for translation into 12 European languages, and for trialling:

- The information to be exchanged must be relevant, stimulating and above all must highlight different perspectives, attitudes and resolutions to issues in different countries. Social and environmental scientific topics lend themselves best to these approaches, whereas the pure science curriculum topics would very often result in the exchange of the same, and therefore rather uninteresting data and other information;
- The units should contain wherever possible, practical and investigative work which may provide an additional stimulus to the text; this work should not require specialised equipment or facilities and therefore would be accessible to all schools;
- The units should be flexible to complement any school curriculum for students aged 14 to 19 years. The units which are translated into 12 languages, should have a cross-curricular appeal, with relevance to language and humanities teachers, as well as to teachers of science; and
- The exchange forms should raise discussion issues of interest and relevance to the student population, so that the exchanges or partnerships formed have the basis for a fruitful extension, beyond the duration of the unit.

All units have the same structure which includes an introduction to the topic, teachers notes, copyright-waived student material, a topic reference section and the exchange form.

In order to facilitate the exchange process, all schools are required to register with the project on an annual basis so that their contact details are entered onto a database of schools. The monthly updated database
is available on the Science Across the World web pages (http://www.hp.com/saw) and is also sent to each registered school three times a year. Information within the database is arranged by countries and includes contact details of the school and teacher, the unit(s) to be studied, the language(s) to be used in the exchange process, the ability and age range of the students, and the month in which the exchange of information can take place with other schools. This simple system enables teachers or students to select schools in desired countries using the same unit, in the same language at the same time as they are, so facilitating a smooth dialogue interchange via the exchange form.

Future Developments for Science Across Europe

As a result of recommendations in the above evaluations and discussions within the SAE team, the Science Across Europe project will be concentrating on the following—with a visible dissemination strategy, embedded in a national context if possible:

- Certain countries with small numbers of participating schools at present, will be targeted through a programme of teacher training. It is not the aim of the project to recruit maximum numbers of schools; rather to have viable overall numbers which are actively participating and benefiting from their involvement.

- Current individual country accreditation methods and possible methods of implementing SAE training courses within existing initial teacher training courses and in-service training courses, at national levels, is being investigated.

- The importance of end user/student evaluation is recognised and evaluation methods aimed at the student audience, for specific units are under development. The first student evaluations will be implemented during the trials for the Keeping Healthy unit, from February to April 1998.

The project wishes to thank Evelyn van Dyk, the former SAE project manager, John Hughes and Andrew Hunt, as former project directors for their comments.

References


Science Across the World web pages:
http://www.hp.com/saw
ISSUES IN ELEMENTARY SCIENCE TEACHER PREPARATION:
A COMPARISON OF PROGRAMS AT HACETTEPE UNIVERSITY (TURKEY)
AND TEXAS TECH UNIVERSITY (USA)

Julie Thomas
Texas Tech University
and
Fitnat Kaptan
Hacettepe University

Is there a universal concern in the design and practice of elementary science teacher preparation courses? This article will trace the rationale and practice of a science methods course in Turkey and a comparable one in the United States. What are the similarities and differences of these courses? What can one professor learn from another?

Education Programs

Hacettepe University is located in Ankara, Turkey. The elementary teacher education program accepts approximately 45 students each year into a four year degree plan which includes a balance of learning experiences including general knowledge, field knowledge, and knowledge of teaching methodology. The area of general knowledge helps students acquire the consciousness and ability to recognize individual and social issues, seek solutions and contribute to the economic, social and cultural development of Turkey. Field knowledge consists of the knowledge of teaching principles and methods of courses taught in primary education institutions. Knowledge of teaching methodology consists of the knowledge of general teaching principles and methods. Elementary teacher candidates complete field observation in the 7th semester and practice teaching in the 8th semester.

Texas Tech University is located in Lubbock, Texas. Tech students must complete academic foundation courses before they can be admitted into the elementary education program. Thus, approximately 120 students are selected as juniors and must meet admission standards including a GPA of 2.7 or higher, high ethical standards, and English language proficiency. The program is based on a philosophy of reflective analysis, inquiry learning, rational decision making, and merged educational theory and practice. On admission, students join a cohort of peers and follow a strong, sequential, clinical, program based on reflective practice.

The Texas Tech program, just celebrating 20 years of service, is nearly three times the size of the elementary teacher education program at Hacettepe University which is in its sixth year of operation. Though both universities focus teacher preparation program on very similar philosophies regarding field experience, the Texas Tech program affords formal arrangements with elementary school partners while in Turkey, five hours of observation a week is left to university students to arrange themselves. Perhaps the major difference in program planning is limited access to elementary classrooms in Turkey.

Elementary Science Methods Courses

At Hacettepe University, the elementary science methods courses focus on science as 1) a body of organized information and 2) the systematic methods (i.e., observation and information collection) necessary to understand it. The course directs elementary science teachers to develop and interest in science; knowledge about the environment; problem solving and thinking skills; observation and experimental methods to understand scientific results and laws; and an understanding of the relationship between science and technology.

At Texas Tech University science is a way of learning about the natural world. Preservice teachers learn to understand that science in the elementary school
can be 1) developed from real world situations through the use of hands-on, minds-on lessons and should be 2) guided by new standards and current research regarding the teaching and learning of science. The science methods course is field-based and taken during the second semester of the junior year. In this course, Tech students spend a minimum of 15 clock hours teaching science lessons in elementary classrooms. They are expected to develop hands-on, inquiry-based lessons, to adapt lessons for children with special needs or diverse cultural backgrounds, and to apply technology when possible.

The methods course at Hacettepe is primarily lecture-based due to limited lab space and materials as well as limited access to elementary classrooms. Thus elementary teachers in both universities are encouraged to teach hands-on science, but students at Texas Tech actually experience hands-on model lessons and practice hands-on teaching with elementary students. Additionally, Texas Tech students have greater technology resources which include Internet and other relevant computer applications.

Methods Course Content

At Hacettepe University the science methods course focuses on the National Curriculum of Turkey, grades 4-5. In the first three years of elementary school, units of Social Studies and Science are joined together in a single Life Science course. At the 4th and 5th grade levels Science and Social Studies courses are taught separately. Fourth grade science units include Earth and Sky, Life Science (Plants and Animals), Healthy Environment, Matter, Light, Electricity, Energy (Solar, Water, Wind, Fuel, Recycling) and Nutrition. Fifth grade units include Human Body Systems, Ecology, Matter and Energy, Sound, Light (refraction, vision), Heat (sources, effect), and Electricity (static, current).

At Texas Tech, students become aware of the National Research Council Science Standards as well as the Science Texas Essential Knowledge and Skills (TEKS). These identify the standards for science teaching and learning in Texas and direct the science curriculum in every public school in the state. Specific processes and concepts are defined by grade level from Kindergarten to sixth grade. This methods course does not address all elementary science content, but lays a helpful foundation for wise decision making regarding elementary science teaching.

Science education in the fourth and fifth grades in Turkey is fairly critical since most Turkish citizens (55 percent) have completed their formal education by the end of fifth grade. In addition, junior-high-bound students are anxious to do well on the high school entrance exam as their score will determine which high school they may attend. For these reasons, elementary science teaching in Turkey strictly follows the National Curriculum. In Texas, elementary children are not tested in science. Elementary science is thought to lay the foundation for more content-based science learning in junior high and high school.

Instructional Format

Teaching methods and technologies used in Hacettepe University elementary science courses include concept mapping, cooperative learning, observation, discussion, demonstration, problem solving, hands-on activities, questions and answers, reading, fair project. Students learn to choose the most suitable method according to instructional objectives, ability level of the students, classroom conditions, available equipment, and experience, knowledge and ability level of teacher. Students also learn a variety of organizational techniques such as teacher-centered teaching when all activities (lecture, demonstration, etc.) are done by the teacher; student centered teaching in which activities are done by the individual student; teacher-as-guide, when the teacher directs individual students or group work.

Elementary teachers are required to prepare a series of plans—annual plans, unit plans, and daily plans. Annual plans provide an overview of the school year and unit plans indicate the details of the course content, and the teaching plan. Daily plans explain the course activities and how they will be applied. Detailed and successful daily plans include specific content; instructional objectives; a list of visual and audio equipment, books, and teaching aids; and evaluation of learning. Evaluation is one of the most important processes of the teaching and learning process and includes a measure of achievement as well learning needs. Curriculum plans must include special, national events defined by the Ministry of National Education since all Turkish elementary teachers are expected to do some activities related to these events. Special weeks (related to social studies and science) include: Food Conservation and Nutrition, Turkish Standards, Energy Conservation, Forest Week, Museum Week, Healthy Heart Week, and Environmental Protection Week.

Teaching methods at Texas Tech University focus on hands-on, inquiry. Students participate in model lessons from a variety of print resources as they become familiar with the science processes of thinking and problem solving. Lessons include mini-lectures but are
primarily organized as active, small group or whole class experiences. Students prepare a unit plan which includes ten daily lesson plans. Significant components of the teaching unit include necessary teacher background knowledge, a plan for authentic assessment, and connections across the elementary curriculum (i.e., math or reading).

By way of comparison, the instructional format at Hacettepe University is defined by the Ministry of Education. The program teaches future teachers what they will be required to do to implement the National Curriculum. The Texas Tech program introduces future teachers to a teaching model that will enable them to teach science in a self-contained classroom. Additionally, Tech students have the opportunity to connect a variety of resources to merge specific science content to appropriate elementary learning. Tech students are encouraged to recognize the creative teaching opportunities in this process.

Materials and Equipment

In Turkish elementary schools, all text books are chosen by the elementary teachers. For this reason all teachers should know some selection criteria. Textbooks must help to teach all objectives that are described in curriculum, present correct information, be appropriate to learning and understanding levels of students, encourage students toward reading, observation, and research. Additionally, elementary teachers are encouraged to other materials like methods books, encyclopedia, periodical teacher books, curriculum book, etc.

Learning how to select and use science equipment makes the teaching and learning process most effective. Equipment knowledge necessarily includes awareness of natural materials, models, dramatizations, exhibitions, computer software programs, educational TV programs, slides and films, radio programs, resource people, and written documents.

Technology equipment used in elementary science courses are designed and developed by Ministry of National Education Course Equipment Development Center. The Science Course Equipment Kit consists approximately one hundred different materials and is distributed to elementary schools by the Ministry of National Education. Educational films radio programs for all levels of education are developed and distributed by the Film, TV, and Radio Education Center. Also a Department in Ministry of National Education is responsible for the production of software for computer supported instruction, but preparation and usage of these programs are not common.

At Texas Tech University students are introduced to state-adopted elementary science text books as well as six ancillary science teaching curriculum resources. One of these includes membership in the National Science Teachers Association. This membership entitles students to receive a professional elementary teaching journal. Computer access allows students to exchange e-mail, explore Internet, and experiment with instructional materials such as CD's and computer software. Students are encouraged to select, develop, and use a variety of meaningful learning experiences in science for children.

Texas Tech students have access to a wide variety of teaching resources and materials. At Hacettepe University, students have fewer resources to choose from. This is one reason the science methods course is lecture-based; very few books about teaching science are written in the Turkish language and students do not have access to computers or Internet.

Conclusion

It seems that there is a great similarity in the foundational structures of the science preparation of elementary teachers at Hacettepe University and at Texas Tech University. We teach in different countries and realize different funding opportunities, different graduation expectations, and different teaching resources.

Hacettepe University (as well as the general Turkish system of education) suffers considerable limitations. Realizing this, the Turkish government is currently generating system-wide changes in teaching and teacher education. Considerable change is beginning at Hacettepe as well as in the country of Turkey. The Elementary Education Department is continuing to find better ways to educate teachers and improve the science methods course. Also, the developing Elementary Education Department of Hacettepe University is aggressively increasing education projects to increase the department budget. New budget money will be used to enrich the department’s facilities in the areas of lab equipment, computers and computer software, Internet connection, and textbook packages.

Compulsory education in Turkey will soon be increased from five years to eight years. This means the elementary science methods courses will change,
and there will be more time for hands-on activities which enhance and develop thinking skills. Another important change is that collaboration between university faculties and practice schools is increasing. This will increase the possibilities of field experience during methods courses.

In connection with the National Education Development Project (NEDP), selected education faculty have been sent to the United Kingdom and the United States to observe and collect information about other teacher education systems and methods courses. This project will eventually support the development of improved methods course textbooks and materials.

By comparison, Texas Tech University is a partner in the National Science Foundation (NSF) funded Texas Statewide Systemic Initiative (Texas SSI). Tech is also seeking to improve elementary science teacher preparation and currently focusing on improvement of the required 12 hours of science content courses. The intent is to develop science courses to meet the specific learning and teaching needs of elementary teachers. Thus, both universities are engaged in change—local change and national change. It is interesting to realize we are guided by similar philosophies though limited by different political and economic parameters. Still, the shared comparison of university programs lends insightful opportunities for personal as well as institutional growth.

References


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DEMYSTIFYING CONSTRUCTIVISM: SPONTANEOUS AND GENUINELY
CONSTRUCTIVIST TEACHING IN DISADVANTAGEOUS CONTEXTS

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Abstract

In the last two decades, constructivism applied to education has been recognized as a potentially better way to deal with teaching and learning. A review of literature appears to show that, particularly in developing countries, teachers working in natural settings use practices that do not reflect constructivist teaching. A qualitative study was carried out in the Northeast region of Brazil (a poor and problematic area) to investigate whether constructivist teaching practices are evident in everyday lessons in state primary schools. Surprisingly, some teachers were found to subscribe to and use genuinely constructivist methods. The theoretical background, methodology and implications of this finding are presented and analysed.

Introduction

Constructivism is emerging as the new orthodoxy in science education. Nevertheless, as Nussbaum (1989) emphasized, constructivism is not monolithic. Consequently, it is important to define and characterize a constructivist approach in education, in order to give a theoretical basis for any research. Our approach has been mainly based on ideas developed by Gilbert et al. (1982), Posner et al. (1982), Driver et al. (1985) and Fensham et al. (1994). These authors emphasise ‘the active pupil reaching out to make sense of events, engaging in the construction and interpretation of individual experiences.’ For teaching to be appropriate it must complement this process.

From a synthesis of the ideas put forward by the researchers cited above, a profile of a constructivist teacher was constructed and is summarised.

The constructivist teacher will:

1. use student’s ideas to plan lessons (the teacher should have a prior awareness of the ideas which pupils bring to the learning situation);

2. use pupils’ ideas in the development of the lesson, as it happens (the teacher should use of teaching techniques which involve challenge to, or development of, the initial ideas of the pupils).

The genuinely constructivist teacher will assess, discuss, test and constantly use pupils’ ideas when leading learners to an understanding of new scientific concepts, laws and principles. With this description of constructivist teaching, the problem investigated by the present study can be stated by the following question:

Is it possible to find primary science teachers who already use this approach in ordinary situations? More specifically, is it possible to find constructivist practices in spontaneous ‘good practice’ (or does constructivist teaching need external stimulation and expert advice)?

A review of the literature indicated that the majority opinion is that spontaneous constructivist practice was unlikely, even in developed countries (Eaton et al., 1984; Hendry & King, 1994; Hewson & Hewson, 1983; Sequeira et al., 1993). In developing countries, such as Brazil, the context is even less conducive to the development of constructivist practices: state schools are badly equipped and teachers have to deal with crowded classes and a great heterogeneity of students with respect to age, ability and level of motivation.
There are reports of projects which have developed constructivist teaching practices. Tasker et al. (1980) and Scott (1987) described the implementation of projects at the University of Waikato, New Zealand, and at the University of Leeds, England. In both cases, a team of researchers helped teachers to implement constructivist approaches at their classes. Some of the teachers involved concluded that, at the beginning, the process is time consuming and very difficult. After some trials, which were followed by evaluation, the results showed that the constructivist methods were practicable and did improve students' meaningful learning. Jofili and Watts (1995) evaluated a kid of intervention into teachers' professional development and concluded that teachers involved in the project (from northeastern Brazil) faced many difficulties trying implementing constructivists approaches in their lessons but were very committed to continuing despite adversity.

If constructivist teaching practice could be found in disadvantageous contexts, which have not had the intervention of external support from research teams, it will have fruitful implications. Other teachers could be encouraged to adopt constructivist practices with confidence that they are practicable. Local examples are always more convincing than theories developed elsewhere.

Methodology and Results

The research was designed, loosely, within the specifications of a case study (qualitative approach). Individuals were to be studied and described as they taught their lessons. Three research instruments were developed: a personal interview, a method of classroom observation (the main instruments) and a questionnaire. The latter instrument was applied only to test the results on a bigger sample of Brazilian primary science teachers.

The science topic “The Law of Floating Bodies” was selected as the topic to contextualize the questionnaires and the interviews ‘questions with which to search for teachers’ ideas about constructivist teaching practices. This topic involves the teaching of a kind of knowledge which is usually classified as functional or procedural—it is knowledge which is actively used in daily encounters with the ordinary physical environment. Pupils are familiar with and deal frequently with things which float. As a consequence, the related knowledge might be very difficult to develop since ideas which have learned from this real experience may differ from the scientifically more “correct” knowledge which is to be taught.

The topic also involves the teaching of abstract and complex relationships (proportionality) among basic concepts (mass and volume). This is recognized to be a challenge for teachers and certainly will call for careful teaching. Also there is in the literature much research (since Piaget in 1929) describing children’s ideas as well as teachers’ efforts to teach the topic of floating bodies in primary school.

The research instruments were validated and adjusted in two pilot studies, the first one in England and the second one in Brazil. In England, the instruments were applied to nine science teachers working in four state schools. In Brazil, they were applied to five teachers and to five educationalists. The results obtained in the pilot tests indicated that the instruments were reliable and were ready to be used in the main study.

The main study involved twenty-four state primary science teachers, selected at random from eighteen state and city schools, in the city of Fortaleza, the capital city of the State of Ceara in northeast Brazil. It was decided to observe lessons taught to sixth graders (mean age around 12 years old) as this is about the age at which the law of floating bodies is taught. The teachers were observed usually for two lessons of fifty minutes each and they were interviewed immediately afterwards. The questionnaire was sent to a different randomly selected sample of teachers of sixth grade and was answered by forty-seven state primary science teachers.

The basic designs of the interview, classroom observation and questionnaire schedules were as follows. The results will also be described and analyzed.

1. The interview

This presented four teaching strategies representative of traditional practices and four typical of constructivist practices. The teachers were asked to analyze the practices and give their opinions about their use. The answers were recorded as “partly,” if the teacher subscribed to strategies from both categories, “yes” or “no” in each case, if he/she totally accepted or refused either of the two categories. From twenty-four interviews, nine (37%) were labeled “partly,” eleven (46%) subscribed to the constructivist strategies and seven (29%) to the traditional ones (some teachers totally selected more than one category).

A question then asked how the teacher normally introduced a new concept. Many ideas followed from this question. Five teachers described completely constructivist approaches and refused traditional ones.
They claimed that normally start lessons from students’ ideas and continuing using their ideas on the further development of the lesson.

Another question asked for the teachers’ reactions to wrong answers by pupils to teacher questions. The same five teachers said that they normally rephrased the questions in order to allow students to think more deeply and restructure their answers. Other teachers said that they ask another student to correct the answer, or alternatively give the “right” answer themselves.

The last question asked the teachers to suggest an ideal way to teach “The Law of Floating Bodies,” given ideal conditions. The five above mentioned teachers suggested an experimental approach (as did some of the other teachers). One of the teachers from the group of five said that she would use the same sort of lesson as she normally did except that she would use more material resources to enrich the learning experience.

2. The classroom observation schedule

This was constructed around two dimensions of classroom activities which might show constructivist teaching in action. The first was a checklist of four teaching activities that might be observed in classrooms which were considered to be representative of constructivist practices from literature descriptions of the approach. These practices were assessing, discussing, testing and applying students’ ideas in a variety of different ways. The second dimension was ordinary strategies for developing activities in class—oral and written questions, homework, small group work, demonstration, hands-on experiments and others. The results show the existence of these two dimensions in varied proportions in the observed lessons of the twenty-four teachers, teaching sixth-graders. The five previously mentioned teachers developed all of the four specified categories (assessing, discussing, testing and applying students’ ideas). Other teachers only use some of them.

The results also show that small group work was a very common strategy (and is one of the most important strategies according to constructivist researchers specially the Vygotskyans) and that only one of the teachers was able to develop hands-on experiments. This teacher taught in the only of the observed state schools that had a proper laboratory.

From the interview and classroom observation results, each teacher was classified as traditional or constructivist. This classification showed that from twenty-four teachers five (21%) subscribed and behaved (while teaching) in a constructivist way. Sixteen (67%) teachers subscribed and adopted traditional approaches and three (12%) were classified as “mixed” because they subscribed and adopted some traditional as well as some constructivist approaches.

3. The questionnaire

The questionnaire presented seven teaching strategies, varying from traditional to behaviourist, including some typical discovery learning approaches. The teachers were asked to analyze and give opinions about each of them. The results of the questionnaire (answered by forty-seven Brazilian state science teachers) showed that 28% of teachers explicitly subscribed to teaching practices based on the use of students’ ideas and which are broadly constructivist in approach.

Although information about student achievements were not part of the present research, some indirect data was available. This might give some clues about the profiles of students taught by some of the teachers. Students of five of the teachers belonged to the sample selected for interview and observation commonly entered projects in the Science Fairs held in the state. Three of these teachers have been classified as genuinely constructivists. The level of independence, criticism, originality and high level thinking skills possessed by pupils who contribute to the Science Fairs is often remarkable and it is interesting to speculate that these qualities have been fostered by the constructivist styles of the teachers, or perhaps that teachers who use a constructivist style are also able, by whatever means to stimulate their pupils. Not too much should be lead into this finding, though it is interesting that not one of the traditional teachers had pupils who entered for the Science Fairs.

Conclusions

In summary, the basic question posed at the beginning of the work can be positively answered. Some Brazilian state primary science teachers did use genuinely constructivist lessons in very unhelpful contexts. These teachers have had no in-service training courses emphasizing constructivist practices, nor did they learn about these things in their initial training (the majority of the teachers had been teaching for more than 10 years and, in any case, the teacher training curricula in Brazil are very out of date). These findings were surprising for the following reasons:

1. According to our review of the literature, the spontaneous constructivist practices should not have
happened; even in projects supported by teams of researchers, teachers had difficulty implementing and continuing constructivist practices in normal classroom settings.

2. Brazilian state teachers work in very problematic contexts. The social and economic background of their students is usually poor. The number of students per class (often more than 50) is high if compared to European and North American schools. There is a great heterogeneity of ages in each class. Material resources, such as textbooks and any kind of equipment, are often non-existent.

One interpretation of the findings is that constructivist practices come, especially in unhelpful circumstances, not from theoretically contrived new practices but naturally from common sense, internal epistemology (including a care for students), professional and political commitment. Appleton and Asoko (1996) described a teacher’s progress toward using constructivists’ approaches in his teaching some time after an inservice activity and concluded that the extent to which the teacher used teaching principles based on constructivism was influenced by his views of science and of learning, how he usually planned his teaching, and his confidence in his own understanding of the topic.

Maybe the observed Brazilian teachers who used constructivist methods valued and used the students’ ideas in lessons because of a common sense of good teaching which naturally causes them to constantly seek to know their students’ progress and to be in touch with their students’ development. This will happen, with some teachers, whatever the classroom circumstances. With other teachers, whatever the entreaties of researchers and curriculum developers, change may be difficult to bring about.

From these results we believe that a better way to bring about ‘constructivist practice’ may be to sensitise teachers to the good, natural qualities of their common sense approaches to the pupils, most of them also present in the majority of lists of prescribed constructivist practices. Together with some theoretical underpinning of the constructivist ideas in Education with support and encouragement for teachers to reflect on their own practices, this may be a more effective way to develop constructivist features to classroom practice. Local examples presented and discussed in short inservice training programmes might also be useful.

It is possible that the development of constructivist teaching may be being retarded by the weight of theory and suggestion of newness which inevitably accompany newly developed and well researched teaching approaches. Perhaps if constructivism were demystified and placed in the context of common sense good practice, then it might be easier to foster. As Joffili and Watts (1995) concluded, constructivism may not be the only, or the best, way of working in certain situations and circumstances but in this very moment it provides an excellent opportunity for changing both teachers’ thinking and behaviours and children’s conceptions in the classroom.

Acknowledgement

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References


Science for the Millennium

Key Information Sheet
International School Science Links 1999—Project 2000+

Science Links
There are many schools already involved in linking and there are several different types of links, e.g., through letters, e-mail, fax, visits and exchanges. As we near the year 2000, ICASE in conjunction with ASE (UK) felt that it would be an ideal opportunity to build on existing links and to encourage the formation of new ones between schools in different countries. In this way we would be making a contribution to Project 2000+, the international project working towards achieving scientific and technological literacy for all.

Why get involved?
A link provides an ideal way to widen the horizons and increase the motivation of pupils. To get to grips with a scientific problem, share ideas and findings can enrich a science curriculum, and can also provide the opportunity to find out more about another culture. This will promote international communication and understanding between schools and cultures as well as providing lasting friendships.

Ideas for science links.
You are free to choose any topic, of interest to the two schools. It is helpful if the theme enriches the science experience of both schools by giving a wider context for study of the topic and also links school science with pupils' everyday lives. For example, possible topics might be nutrition, balanced diets, environment—local pollution, energy use, useful chemical reactions (soap making, fermentation baking).

How long should the project last?
There is no definite time scale and different approaches may need different times. There are no hard and fast rules!

What happens when the project is completed?
Tell us what you and your partner school have learned. You can do this in any appropriate format, e.g., in poster, a short video or tape, a science report. This should be sent to Jack Holbrook at ICASE or the ASE (UK). All participants will receive a certificate and in the year 2000, there will be an international ceremony to celebrate the work achieved through the links. Schools which produce the best project links will be invited to participate. We would need to hear of your project and link before December 31st 1999 if you wish to be considered for an award. However we believe that your greatest award will be the pleasure of the link process as you work with your partner school.

Contact
Jack Holbrook, Executive Secretary, ICASE, P.O. Box 6138, Limassol, CYPRUS.
INSERVICE SCIENCE COURSES FOR PRIMARY TEACHERS:
IMPLEMENTATION OF DIFFERENT TYPES OF
INSERVICE TRAINING COURSES IN FINLAND

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Abstract

The effects of six differently organized primary inservice training courses on teachers motivation, anxieties, hands-on working skills and needs of support were studied and the areas in which teachers needed most support were evaluated. The total of 140 primary teachers attended workshops lasting from six to nine hours. Both written and verbal evaluation were used in assessing these workshops. Teachers found, with no exception, the inservice training very important. This study shows that, above all, primary teachers felt they needed more continuous support in the area of improving their knowledge and understanding of the subject, especially in the area of chemistry and physics. They also wanted more practice in experimental, problem solving oriented hands-on activity planning as well as the knowledge of availability of necessary classroom equipment and materials. Primary teachers felt quite lost about progression in scientific concepts and the appropriate content of science curriculum in different primary levels.

1. To support teachers motivation and self confidence and reassure them that they can facilitate good science education in their classrooms.
2. Help teachers improve in subject matter competencies and instructional skills.
3. Get teachers aware of simple hands-on activities they could use in primary classroom and the use of simple household materials in science teaching.
4. To heighten knowledge of availability of the necessary classroom science equipment and supporting materials.
5. To reassure teachers on that teaching of science should arise out of the children’s spontaneous curiosity.

Learning in science is a product of the interaction of attitudes, ideas, concepts and process skills. Pupils’ attitudes towards science have been widely studied (Canary & Seabold, 1994, German, 1988) as well as children’s ideas and concepts concerning science (Driver et al., 1985, Driver et al., 1994). Ideas and concepts are formed by children as a result of a variety of influences and process skills ability can be developed through practice. While knowing all that, we should realise that through primary science we need to help children to understand first of all their immediate environment. We need to pick the phenomena that we talk about as near of children’s own world as possible. That is why topics used during these inservice training courses concentrated on simple household materials, simple electrical circuits, light, colours, food, water, etc. We should also keep in mind all the time that, no matter what subject we teach, learning is always the process of developing and teachers need all the time to build up the strong relationship with his/her pupils (Bullough & Giltin, 1995) and should feel empowered (Bell & Gilbert, 1994).
Goals

The following goals were addressed:

1. development of positive attitudes toward science teaching and learning;
2. help primary teachers to find science teaching motivating and make them aware of the great variety of integration possibilities;
3. strengthen teachers self-confidence and familiarity with the basic science equipment and available materials;
4. give teachers experiences with hands-on activities and knowledge that no special equipment are actually needed to teach science in primary level;
5. address the conceptual understanding of science as a process rather than a set of facts;
6. give some content advice; and
7. creation of science learning groups through computer net.

Planning

The workshops were administered through the County Governments and arranged by the Department of Teacher Education together with local subject teachers. The primary concern was to help teachers develop instructional strategies using simple mainly "home made" equipment and usual household materials for teaching science on primary level. In each workshop teachers received the workshop book, that included all hands-on activity instructions used during the course.

During four years, six primary inservice training workshops were arranged in four different places (Heinola, Jyvaskyla, Kuopio and Vaasa). Two workshops were held in Jyvaskyla and Vaasa in two year period. The total of 140 primary teachers were attending these courses (20 - 30 in each course). One workshop lasted usually from six to nine hours.

Personnel

The instructional personnel varied in different sessions. In each workshop there was a professional science educator present and additionally:

a. in first workshop no other leaders
b. in second workshop two area subject teachers
c. in third two student teachers
d. in following three workshops 2-6 area subject teachers and one primary teacher (biology, chemistry, physics and mathematics).

Notices were sent through the local County Governments and in one case through the University.

The participating teachers represented all types of school districts and different types of primary schools. Some came from so called "village schools" where one teacher teaches both levels one and two and the other one both levels three and four. Some teachers came from the ordinary primary school where one teacher teaches one class. The attending teachers had masters degree in education and were qualified for primary teachers. Most of them had not attended any science education class after high school and some had attended only one compulsory chemistry class during three years high school period. In two courses both primary and secondary level teachers of the same regions were present and worked together as a team.

Contents of the courses

The importance of teaching meaningful, hands-on activity oriented science in the primary levels and the ways that can help doing that were the leading thoughts when carrying out these inservice training courses.

Through all the workshops much attention was paid to the emphasis of encouraging teachers to use children's natural curiosity—their basic nature of questioning things—as a basic power resource and stimulator. Teachers were continually reminded that no matter what teaching methods they would be using they should give children more time to think, why he/she is doing what he/she is doing and why is the teacher asking him/her to do so. Learning science is a process that needs time to go on and children should be allowed to use their knowledge systematically, solve problems and make decisions. They should be encouraged all the time to rely on their own experiments and results and make them aware of, that some phenomena they can only understand based on their further experience. Pupils should also understand that there can be different answers to the same problem and that all the answers can be as good. The value of the answers depends on the pupils explanations and how well they can argue their own decision.

Teachers need to develop positive attitudes and reflective assessment to reach the demands that children of this generation will be setting for them. During all these inservice training courses much attention was paid to the co-operative group work. It is going to have an important role in future classroom allowing teachers more time to observe and challenge pupils directly. Activities used during these courses were designed to motivate teachers to include more science contents in their teaching, develop self-confidence, alleviate science anxiety and promote hands on experiences.
All six inservice training courses were based on process-oriented, problem solving activities and group work. Specific topics included: hands-on science activities, process skill activities, questioning strategies and innovative planning and use of home-made equipment for different purposes. The scientific concepts taught during these inservice training courses were very simple ones, example: acid-base, indicator, solubility, saturated, density, volume, pressure, warmth, light, colour, electricity, energy etc. During each workshops adequate discussion breaks that enabled teachers to express questions and realise common concerns were provided. Each workshop enabled each participants to leave with ready-to use materials. Arranging some of these workshops in local elementary schools brought them closer to teachers everyday life and assured them that the requirements were not so demanding as many of them had thought. During the last hour of each workshop teachers evaluated the course, gave the feedback and reflected their own contribution in their learning process.

Comments about teachers implementation the ideas—that they had learned during the course—into the classroom were asked by interviewing some of attendees afterwards. Several teachers attended courses in different years. Registration fees varied depending on the County Government support. The amount of teachers who wanted to attend was related to the amount of the registration fee. This was actually obvious, because the money that the schools have for inservice training per teacher in academic year is approximately 600 Fmk.

The effect of using different lecturer combinations on the learning of teachers

It goes without saying that, if there is one or two teachers for 20 students, this affects learning. It is not however necessarily so that in a usual classroom the pupils will learn more if there are more teachers present, actually it can be just in opposite way. In these inservice training workshops it was however noticed that if there were more than one instructional persons at present during the workshop period, teachers felt more free to ask them help. There was not very much difference if there were subject student teachers or subject teachers present. It did not seem to make much difference ether whether there was one primary teacher and one or more subject teachers present during workshop. Only thing that really mattered was that there were more than one teacher around: "It is nice that there are more than one person to ask." "Different teachers that are responsible for different experimental 'stops' save a lot of our time, because we can have answers to our problems right away."

The materials

A workshop book including these inservice training hands-on activity course material, has been developed and some have been published as a separate book (Asunta, 1993) or integrated in the material for secondary and high school levels (Asunta & Little, 1995; Bader et al., 1995; Asunta & Hakkarainen, 1996). All participants received the written material in the beginning of the workshop. During each workshop there were different hands-on activity books and materials available for teachers to see. Also informational material concerning equipment and supporting materials were available.

Teachers’ feedback

Both written and verbal evaluation was asked after each inservice training workshop. First the teachers were asked to think over themselves answers for questions concerning:

1. their own expectations of the course content and what were they anxious about;
2. why they attended the course;
3. if the contents of the course was 'right' (ratio of introductive lesson and experimental period);
4. what they think they learned;
5. how did they help their own learning; their own commitment;
6. how were they going to use the knowledge that they got during the workshop, in their own classroom;
7. what they were the most excited about;
8. what more support they would need in this area;
9. which were their own strength, where were they skilled of; and
10. what they would think is the meaning of hands-on activity on pupils science learning.

Expectations and anxieties

Most teachers expected to receive from the course both 'hins' for primary science teaching and some new thoughts about what should be dealt with in primary level science. Many teachers wanted to become more familiar with this—as they themselves expressed it—'new and frightening' area. They felt they should know so much more to be able to teach chemistry or physic contents for their pupils. Over half of them expected to get some help for their routine work at school. Some of them mentioned they wanted some knowledge what is going on around the world in this area: "I would like to know how primary science is taught in other countries."
Some other things mentioned were: ‘learn some new methods,’ ‘something new to take into the own classroom,’ and ‘to get more self confidence.’

The reasons for attending the inservice

The reasons why most teachers attended the course were mainly the same as their expectations, i.e., to learn some new things, curiosity, to find out which type of scientific experiments would be useful on primary level, interesting topic, to get some new ideas. Some teachers also mentioned that they felt they needed to find some new ideas to refresh their own classroom teaching, because they had taught so many years without having a chance to attend any inservice training course. Also some mentioned that they were just interested to find out what the topic “Creative science for primary level” had to offer.

About the course content

Teachers’ answer to this question varied depending on how much time for lectures was included in these workshop courses. Most teachers did not like it if more than two hours lecturing was included in an eight hour workshop. Such an answer was not unexpected because the inservice had been advertised as workshop courses and because the course only lasted one day. However, teachers also felt that a lecture providing some background information was necessary and that the whole course should have lasted at least two whole days. In one workshop when there was an equal time reserved for lectures and experimental work, teachers gave the feedback that too much time was spent for lectures. The contents of hands-on activity part varied a little from course to course. In each workshop there were however both demonstrations and experiments for teachers to learn. No meaningful difference was found in teachers feedback concerning the contents of the courses.

What teachers think they did learn?

Many teachers said that they learned just what they had expected to learn: some new things on primary science area. Some mentioned they had learned logical thinking, and positive attitude towards science. A few teachers mentioned that they had had fun and they would think children would feel the same way after having a chance to do things like they had been doing during the workshop:

“I learned how to do some experiments that would interest primary children.”
“I can try almost anything as far as I do have enough skills and I know my pupils well enough.”

“There are a whole lot of scientific experiments that I can use even in the first grade.”

How did they help their own learning?

Many teachers either could or would not answer to this question, many questions, tried many new things even being a bit afraid not to know how to manage and been interested:

“I have been curious.”
“I put my own spoon into the soup.”
“I was a good listener.”

Do the teachers think that the knowledge they got will be transferred to their own classroom?

Almost all of the participants thought that they would be using some of the activities in their own classroom:

“I am positive.”
“I will remember not to give children ‘the right answers’ and reserve more time for discussions.”
“I really hope I have enough courage after this course to use all these applications in my own classroom.”

Many teachers said that they will try to develop their own teaching so that it would include more hands-on science activities.

What were they most excited about?

The demonstrations which the teachers considered the most exciting were: “floating potato,” “oil and water,” “how to get a boiled egg to an Erlenmeyer and back without breaking it,” and “the liquid rainbow.”

The experiments that teachers preferred were: “starch from potato,” “indicators from the nature,” “make your own sheet of paper with flowers in it from recycled papers,” “potato that is excited,” “eggs with different colours,” and “who left the note.”

Many problems that were presented to teachers during workshop also made them excited. For example the activities: “what makes rainbow?” “why is wet sand darker than dry sand?” and “why does not the light go through your hand but only makes a shadow?”

An example of demonstrations and experiments used

Floating potato

Teachers were presented a high glass with some liquid in it. In the bottom half the liquid was red and in
the upper half colorless. There was the potato floating just in the middle of the edge of these two colours. Teachers were asked to think over what was the explanation for this. They were also asked to think over if there were more than one possible explanation and what previous knowledge pupils should have before they are capable to answer this question.

**Indicators from the nature**

Teachers were asked to study, for example, which of the following flowers and berries can be used as an indicator: tulip, violet, wood sorrel, white oxeye, blue wild pansy, blueberry, priether, lingonberry and cranberry juice.

Because microwells and very familiar household materials such as orange, citron, applejuice, cocacola, coffee, vinegar, baking powder, etc. were available, teachers could very well figure out what to do. Only in few cases it seemed necessary to advice teachers what the word 'indicator' means and how they can use just the ordinary household materials to test if some plant is an indicator or not.

Science educators designing the workshops in the future should be aware at least the following:

**What more support did the teachers think they would need?** When teachers were asked what would be the areas where they would need more support, they mentioned first of all the following:

a. more information about the availability of necessary classroom science equipment and materials;
b. more knowledge about easy hands-on science activities and scientific knowledge behind those activities;
c. more knowledge about what science-topics should be included in teaching in different primary levels;
d. inservice training for improving the subject matter competency especially in the area of chemistry and physics;
e. practice in experimental, problem solving oriented planning and advice to improve the instructional skills; and
f. availability of suitable, simple activities they could use without danger and with sometimes quite unlimited knowledge of chemistry and physics.

**What is the opinion of teachers on a meaning of hands-on activity on pupils science learning?**

One teacher had answered to this question: “Can there be any learning without doing?” Most teachers thought that pupils learning only happened through their own experiences, through doing experiments. So they thought it is really important to try to use as much hands-on activities as possible at school:

“Knowledge can become internal only through active working.”

Teachers also thought that hands-on activity has an important meaning for pupils future learning. Some teachers had evaluated that 70% of the knowledge (OF WHOM?) is coming through ones own active participation. Many of them were of the opinion that different phenomena such as the rainbow and how it is generated can be understood through experiments:

“Only by doing, one can really remember.”

“The creative thinking can be developed only through active experiences.”

“It is all the world for science learning.”

“It is fundamental part of learning.”

**Results and discussion**

The attitudes and concerns of primary teachers were very similar: they all cared about their pupils and were aware of possibilities of science teaching to support learning process. They suffered the lack of knowledge on innovative teaching strategies and resources. Almost without exception they felt that the intensive workshop promoting understanding and practicing different types of science instructions can have effective results in their classrooms. They felt that the mixture of theory and practice integrated together as they were in these workshops should be continued as time to time repeated meetings. Most of the teachers had the feeling that they were, after the workshop, much more motivated to use hands-on activities to get pupils interested in science. Some teachers also felt that the course had supported only a little their subject matter competencies but a lot of the development of positive attitudes towards science.

The teachers reported that during the workshop they had suddenly realised how “everything has connection to everything” and that science really can be supportive subject for many other subjects:

“The teacher made me realise that science is a small part of a big never stopping process that is life and made me really aware of its importance in understanding this process.”

According to the feedback most teachers felt more free to ask if there were more than one instructor available during workshop. It seemed also that the content of the
in-service courses should mainly be based on active hands-on activities. Teachers want to do as much as possible themselves to get practice:

"I feel so safe to try new activities when there are some people around that I can rely on."

"I want to carry out as many experiments as possible, because if I am familiar with the experiments then it is easier for me to teach my pupils to do them."

As odd as it can sound, it has become obvious according to these six in-service training courses, that the knowledge of our primary teachers, when we are dealing with some very basic concepts of science, is very chequered. For example the scientific meaning of acid-base concept is not at all clear for them. There were few teachers who did not know if pH-value two means acidic or basic conditions. I do not doubt that it has been taught to most of them thoroughly when they were pupils at school, but no matter what, it has not become an internal concept.

Interviews and questionnaires indicated that even one in-service training course can substantially improve primary teachers’ self confidence on being able to teach some science for children and motivate them to learn more about science themselves. Also their understanding of some science concepts was improved.

Inservice had also an activating effect on teachers. During social communication processes created during workshop they learned a lot from each other. Some of them decided to build up the networks with other teachers to support each other. After the first two workshops run several years ago there are still some active teachers who communicate regularly.

It seems obvious that this type of workshop has so many good points that they should be regularly repeated events. There are always many teachers who want to attend the workshops whenever they are available and there would be even more, if the schools would have more money to support their teachers to attend. None of those teachers who attended these six in-service training courses told that they came because their employer forced them to because they themselves wanted to. The fact is that many teachers had been teaching 10 to 25 years without being able to attend even one in-service training course though they had wanted to. Many teachers were still doubtful how much hands-on activities they could try at school because many schools are not at all equipped for teaching science. Even the leader of the course tried to make teachers convinced that with very basic equipment would make science teaching possible, many teachers had a feeling that because their basic knowledge is quite weak it would not be so easy to create simple experiments.

Our primary teachers are confident that the best way of learning is by doing. It means that also us teacher trainees should follow that philosophy. We should compensate as much theory as possible with active participation and conversation: give a chance for us all to learn together.

**key words:** primary science activities, in-service teacher education, material development, problem solving oriented primary science workshop

**References**


Bell, B., & Gilbert, J. (1994). Teacher development as professional, personal, and social development. Teaching & Teacher Education, 10(5), 483-497.


In February 1997 the Open University (OU) was awarded a Queen’s Anniversary Prize for Higher Education. This award, established within the national honours system, was in recognition of the launch and successful development of a new pre-service teacher-training programme, the Postgraduate Certificate in Education (PGCE). The citation accompanying the award included reference to the international interest and significance of the programme and the contribution being made to the training of teachers in mathematics, science and technology.

The award was the culmination of a five-year project that has established innovative applications of open and distance learning to teacher training. In this article I want to explain something of the origins of the OU PGCE, the way the programme is structured, and the relevance of the experience to initiatives being developed elsewhere in the world.

Britain, like many countries, has a shortage of teachers in certain key subject areas, most importantly in mathematics, science and technology but also in modern foreign languages, and even music. In the late 1980s a number of us in the OU began to examine the extent to which experienced adults would be interested in a teaching career. Two market-research exercises, one of which was government-funded, showed some astonishing results. First, amongst graduates in their mid-thirties there existed a high level of interest in switching to a teaching career. Second, the secondary subject areas they were most interested in teaching were mathematics and science. Amongst those interested in teaching at the primary phase, a significant proportion have degrees in mathematics, science and technology.

A new seam of potential teacher recruitment had, therefore, been identified; the average age of potential entrants was thirty-three, and their subject backgrounds were radically different to those who chose to become teachers straight from university. The challenge, however, was to find a flexible and part-time training route. Most potential applicants, for professional and personal reasons, could not attend a full-time course, and the vast majority lived a long way from the few part-time pre-service courses geared to the needs of mature entrants.

In 1992 government funding was received to develop a full range of primary and secondary PGCE courses. The plan was to cover most of the UK and also some overseas countries, particularly within the European Union, where many UK nationals based near English language-medium schools wished to qualify to teach.

The programme was launched in January 1994 and now recruits over a thousand students a year. As predicted, science is the most popular secondary subject, and half of all primary entrants have degree backgrounds in mathematics, science and technology. These entrants also have substantial vocational experience that significantly enriches the teaching population as a whole. International interest has been shown, not only in the programme structure, but also in the research and experience in drawing teachers from the more mature stratum of the population.

The programme is run over an eighteen-month period from January in one year to July in the next. This allows those graduating to obtain a teaching post at the beginning of the autumn school year. The course is divided into three stages and within each there is a period of full-time experience in schools. Potential applicants nominate schools when they apply and regional OU staff verify their suitability.
All students are provided with a wide range of resources covering all aspects of teacher preparation and their specific phase and subjects areas. The experience in schools, the OU resource packs, and a number of OU-edited readers and other set books are all linked in to the student's study guide. The programme has a common overall framework within which the primary and secondary and the different subject areas develop distinctive themes. The framework is a key support to the overall quality-assurance system that underpins each aspect of the course and the ongoing evaluative procedures that annually feed into course review.

The course team took some important initial decisions in developing the programme. First, any reading of activity set for students had to relate directly to experience in schools. We did not want a theory/practice divide. Second, the course team designed a 'curriculum of activities' for each of the programme. Students' experience in school was, therefore, planned to develop progressively. Experienced teachers in the school play a mentor role and facilitate the completion of the full range of prescribed activities. Students also have the support of a locally based OU tutor who provides individual and tutorial support and helps in the running of a series of day schools.

A development that has attracted widespread interest is the provision of a computer for each student. As with many open- and distance-learning programmes, the large numbers create economies of scale that allow initiatives which are impossible in a conventional institutional setting. Students acquire personal IT skills and can practise with software appropriate to classroom use. The most interesting use, however, is for interpersonal communication. Using conferencing software called 'First Class', students are linked to each other, to their tutors, and to a range of electronic subject conferences. They have the opportunity to share ideas and problems, exchange teaching plans and resources, and communicate with central OU academics on all aspects of the programme. A genuinely electronic PGCE 'village' of activity simulates the sort of informal exchange found on a conventional campus. End-of-course surveys have shown that students value this aspects of the programme more than any other.

Experience to date has shown that a course recruits well and has a low drop-out rate. Students are also every bit as successful in finding a teaching post as those graduating from conventional institutions. Every student takes to their place from employment an end-of-course profile, developed from their own course-assessment portfolio, which gives guidance on the sort of further professional development needs an OU PGCE graduate would have.

A great deal has been learned from the first few years of the programme. I have been hugely impressed by the enthusiasm and commitment of our students. Perhaps one of the biggest problems has been to persuade people not to work too hard! Inevitably, those who have made the decision to enter teaching rather late in life take the requirements of their course very seriously.

The programme does have wider international significance and members of the Centre for Research in Teacher Education at the OU, who have produced the course plan and resources, have responded to invitations to visit many countries. I would highlight the following points in this respect. First, it is quite clear that the demands for pre-service, retraining and in-service training of teachers are growing in all parts of the world. The 'bricks-and-mortar' institutions that were developed to respond to teacher-education needs in the twentieth century cannot possibly meet this demand in the twenty-first. Some form of open, flexible learning is essential. New interactive technologies provide new forms of open learning and these are likely to be adapted by 'campus-based' as well as 'open' institutions. Some convergence is already taking place.

Secondly, however, in the context of teacher education, much more attention needs to be given to the school as a 'site' for learning. Too many open- and distance-education programmes have wholly neglected this crucial experiential dimension. The OU PGCE has shown how practical experience can be integrated into course design, allowing the potential not only for teacher development, but also school improvement. Staff from the programme have taken this message to countries and continents as diverse as Albania, Pakistan and South Africa. These are issues of concern for teacher education of global dimensions and, although the precise way this is worked through will vary from one educational system to another, the dissemination of experience on an international scale is already proving of great benefit to those involved.

For further information, including details of all the OU PGCE resources for public sale, write to:
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Pre-service teachers obviously are required to master the basic concepts of their subject. In addition they are made to study general education subjects such as “foundations,” some cognitive psychology and social psychology, classroom management, etc. and then there are “science teaching methods” courses. In many institutions such courses are taken by pre-service teachers from various science disciplines and so the content and experiences in these courses are not very specific for any particular discipline. In some institutions (most teacher education programs in the Philippines) there may only be general teaching methods courses where all disciplines (also social science) are mixed. In others (such as most universities in the USA and Australia) teaching methods are taught to majors of four or five different science disciplines. So in many programs and countries the opportunities to pick up craft knowledge about teaching a particular subject are limited. What could this craft knowledge consist of? Facts about safety precautions in certain demo and lab experiments, knowledge about various alternative ways of explaining a particular Chemistry of Physics concept, knowledge about analogies which could be used, tricks for improvising, general ideas about how to use predict-observe-explain demonstrations for maximum learning and concrete physics and chemistry examples, ideas for role plays to simulate transport of energy in electric circuits, knowledge about applications of particular concepts in everyday life and in technology, ideas for inserting humor and variation in lessons about solubility or atomic physics, suggestions for contacts with industries, etc. Where can one find such knowledge? Well, in science textbooks, in laboratory manuals, in teacher manuals for textbooks, Internet, etc. However, this craft knowledge is highly scattered and it takes teachers a whole life of collecting to build up their resource files. In the following I would like to present several books which are either very useful in developing such craft knowledge in teaching methods courses (1 and 2), or which are dense sources for craft knowledge for the practicing teacher (3-7). The books are not expensive and should be in any science teacher education library. The book that best addresses the questions posed above is number 5, the four volume publication of the American Chemical Society. The book that will be most used by the classroom teacher, might be number 4, Tik Liem’s now famous collection of over 400 demo’s with everyday materials.


In UK pre-service teacher education has shifted from college-based programs to school-based programs. Pre-service students now complete a Bachelor’s level academic program in their discipline and then study for their teacher certification (Diploma of Education) while being based at a secondary school rather than in a university. So all activities for the completion of the Diploma of Education are carried out in and around the secondary school classroom. Learning to Teach Science has been written for activities the pre-service teacher can carry out during school practice (student teaching). It is a book for student teachers and their mentors, yet most activities could be carried out in more conventional pre-service teacher education programs. Monk and Dillon compiled and edited teacher education activities produced by their well known colleagues of King’s College in London. All activities are formulated in terms of what the pre-service teacher (Student Teacher) is supposed to do. All activities have a common format: Student Teacher’s Brief, Objectives, Instructions, followed by some necessary information. In the text preceding the Student Teacher activities, there is often also a Mentor’s Brief consisting of instructions for the teacher who supervises the Student Teacher. That teacher is called Mentor. In other parts of the world various terms are used: Tutor, Cooperating Teacher, Supervising Teacher, etc. Examples of activities are: Directed Activities Related to Text (DARTS) where Student Teachers construct activities which help pupils to study and process science texts (applicable in any country); activities with concept maps and relational diagrams; analyzing investigations for openness; techniques for guiding pupils in open investigations; pupil’s development of inquiry or research skills where Student Teachers go through student reports and notice qualitative differences and compare those with the levels of investigation defined in the UK National Curriculum; planning, organizing, and managing a class practical as
part of a lesson; planning and managing a demonstration with questions and answers; incorporating historical material in a lesson; using video’s; etc. The activities are grouped into the following chapters: **Observing Science Teachers at Work**, **Activities for Pupils**, **Planning and Managing**, **Science Investigations**, **Communicating Science**, **Science and Knowledge**, **Science and People**, **Progression in Pupil’s Ideas**, **Assessment**, and **Progress and Potential**. All of this is preceded by a chapter for the Mentor. Most of these chapters include 6-8 activities which each require quite a bit of Student Teacher time (one or more days). So there is a lot of choice. Some activities, such as planning a laboratory lesson, contain checklists which might be useful to experienced teachers as well.

The activities only contain minimal background readings for the student teachers. Yes, the book does have a bibliography which refers mainly to books. I would have preferred a bibliography with references to articles in teacher journals, or even still having some traditional reading material included in the chapters to make the book more “self-contained.” For example, reading material on the art of questioning, on science processes, on assessment, etc. Nevertheless, the book contains a wealth of activities and students themselves could be tasked to do research and find background readings. For example, on concept mapping and on cognitive conflict and predict-Observe-Explain demonstrations one might well take chapters from **Probing Understanding** (see below). The chapter on **Progression of Student Ideas** has a strong Piagetian streak, no doubt inspired by King’s College Philip Adey who has done extensive work on using science teaching to develop student thinking (CASE program) and has delved deeply into Piaget and other European psychologists. Children science and alternative conceptions are included in the chapter, but, of course, students will have to go to the extensive literature in books and teacher journals to gain a basic knowledge of popular student alternative conceptions in their subject.

Going through the activities, the pre-service teacher will build up quite a bit of craft knowledge. However, the Mentor and the university supervisor should really see to it that the pre-service student seriously builds up the craft knowledge base and does not just “go through the activities.”


During the five years I was training teachers in the Netherlands (1991-96) I used to give this book as a present to graduating Physics teacher education students, except that I gave this present many months before graduation so that I could still give assignments based on the book. The authors of this book are professors and former science teachers from Monash University in Melbourne, Australia. As the title suggests, the authors are very much concerned with understanding and the various chapters discuss different methods of “probing” understanding, methods the authors used in their research. However, these same methods can also be used for “teaching” understanding as they can focus student attention on their own understanding and “exercise” their understanding. The book contains chapters on concept mapping, Predict-Observe-Explain demonstrations (an outstanding chapter!), Interviews about Instances, Interviews about Concepts, Drawings, Fortune Lines, Relational Diagrams, Word Association, and Question Production. The Predict-Observe-Explain (POE) chapter is my favorite. White and Gunstone provide a very nice introduction to POE’s as they call them. Many readers might wonder what fortune lines are. Well, in a story the “fortune” or luck, or whatever of main characters can go up and down. Students are asked to graph the fortune of main characters across the story and such fortune lines will show their understanding of the story, or lack of it. So fortune lines are more appropriate as a technique for exploring student understanding of literature than of science. The other techniques are solidly placed in science. The book is an ideal guide for teacher and student teacher for getting into the heads of their students and studying their preconceptions and conceptual development. Unfortunately it is often quite difficult to get student teachers to pay attention to their students’ conceptions. The first concern of my students in the Netherlands was always classroom control and the next lesson. In those cases where I was able to get student teachers into a little study of student conceptions through diagnostic tests and interviews, the student teachers got quite excited.


This well known physics text for non-majors, meaning students who do not go into engineering or science, is a beautiful resource for teaching ideas. The book is full of examples, links of physics with the environment and every day life, nice pictures which say more than 1000 words, etc. Hewitt does not belong to the “club of misconception researchers” but he artfully touches on all the crucial and subtle conceptual difficulties of students. Even expert readers and teachers might have trouble with some of the conceptual subtleties, but then there are the nice explanations. We ourselves are using the book as a textbook for teacher.
education students coming from the Philippine 4-year secondary school to get a sound grounding in concepts and a wide basic knowledge of applications in everyday life before they move on to the more abstract and calculus-based physics of the typical college texts such as those of Halliday/Resnick and Young.

What can a teacher get from this book?

- hundreds of everyday life examples (see Figure 1);
- hundreds of nice, clear, and attractive explanations;
- hundreds of conceptual exercise questions where Hewitt puts his finger on most of the conceptually sensitive points;
- many ideas for simple demonstrations, such ideas can be found in the text, in pictures on the side of the text (see examples), and quite a few of the conceptual exercise questions at the end of the text can be investigated in simple demonstrations or lab work;

Figure 1. Examples' from Hewitt's Conceptual Physics

The fact that the book is so widely used and now in a 7th edition suggests that by now most errors must have been caught. My colleagues and I found some awkward explanations here and there, but on the whole we like the text very much and get ideas from it. What one does not find in the book are the computational problems we in Physics are so used to. There are many other sources for such problems (any physics textbook), so this is no great disadvantage. In short Hewitt's book should be on the shelves of every teacher all over the world and in the hands of everyone studying to become a Physics teacher. Support materials are available, but in spite of requesting them six months ago, nothing has arrived. Last week I discovered that this was due to the acquisition of the Harper Colling College Division (the original publisher of the book) by Addison-Wesley. There should be a rich store of additional craft knowledge in these support materials (test items, answers to questions in the text, transparencies, lab manual).


This is the ideal source for POE demonstrations. There are more than 400 demos, each described in a handy format, one page per demo with a drawing for the set-up, a few lines of procedures, and most importantly: questions for discussion with students and an explanation. Almost all demos can be done without special equipment and have more or less counterintuitive results. Pupils and student teachers love them, in the Netherlands as well as in the Philippines and Indonesia where I used an early 1980 version of the book for 10 years. Here in the Philippines this book is our main source for our demonstration circus in schools and for peer teaching practice of teacher education students. The book can be ordered directly from the address above or from the NSTA. The price is $40 or $45 dependent on the number of copies ordered, that is US$ 0.10 per demonstration, there are few other things one can do for 10 cents that provide the same amount of fun and satisfaction!

The four volume set Chem Source might well be the best source for craft knowledge for chemistry teaching. All popular topics from junior and senior secondary chemistry syllabi have their own chapter. Each chapter consists of the following parts: Content in a Nutshell, Place in the Curriculum, Central Concepts, Related Concepts, Related Skills, Performance Objectives, Worksheets for Laboratory Activities both in Student Version and with (extensive) Teacher Notes, Demonstrations, Counterintuitive Examples and Common Student Misconceptions, Metaphors and Analogies, Pictures in the Mind, Group Discussion, Tips for the Teacher, History: On the Human Side, Humor: On the Fun Side, Media, Links and Connections (Within Chemistry, Between Chemistry and Other Disciplines, to the Contemporary World), and References. And finally Masters for Transparencies including cartoons (Figure 2). In short, Chem Source constitutes a beautiful knowledge base for chemistry teaching. Chem Source comes loose leaf to be inserted into binders. Let a new teacher start from there and then expand that base by inserting articles from chemistry education journals and other sources and the result would be a lifelong resource. I wish there were equivalent projects in Physics, Biology, and Mathematics which would integrate various knowledge sources as neatly as ACS has done for Chemistry.

Figure 2. Cartoons from Chem Source

Obviously not everything can be put in. The sections about misconceptions are very useful but more in-depth study would require going to articles in journals. Similarly, the content in a nutshell does not and cannot replace a textbook, and the demo's and labs included are but a small sub-sample of what is possible. What I missed were test items, it is surprising that those are missing. However, ChemSource is a great start and resource for any new and practicing teacher.


The book has a long history in spite of its recent publication date. It grew out of a "consumer Chemistry" course taught in the early 1970s to non-science majors. The book represents the author's "craft knowledge" developed over a period of twenty years. Like many of the textbooks nowadays, each chapter has a clear structure with different components.

A discussion of the chemistry principles is prefaced with a demonstration utilizing sample equipment and household chemicals. The demonstration is then revisited after the discussion. The text includes questions to help students check their understanding of a section, worked examples of exercises and problems, a running glossary of the key terms and a short section titled Perspectives that looks at the implications and applications of the concepts. Each chapter ends with some thought-provoking exercises that show the interrelatedness among chemistry, society, and values.

The purpose of the author is primarily to teach chemistry. This is done in the context of familiar everyday materials and experiences. In most of the book the context is the means to the end of understanding chemistry. In the last several chapters, such as a chapter on proteins, the chemistry becomes the means to understand everyday issues such as nutrition. The book is a very helpful resource for teachers who want to prepare lessons that can trigger students' interest and awareness of the chemistry around them. It is worthwhile to have the book in the school library and in the resource room for any science teacher education program.

7. Chem Matters CD-ROM version 1.0. American Chemical Society, 1155 Sixteenth Street, N.W., Washington, DC 20036, U.S.A. Price: $54.95 for a single user and $84.95 for a network or library.

Now this is really a resource where chemistry is used as a means to an end to understand things in life.
Chem Matters contains many chemistry related readings on a single CD-ROM disk. You want to teach about acids and give examples from fruits, look for the oranges article. What about chemistry, drugs, and zombies? A very interesting article reports over 10 years of anthropological and chemical research. Chem Matters is a popular chemistry magazine for high school students which has published a great variety of articles: Bubble Gum Chemistry, Ice Cream, Crazy Candies, the chemistry of Post-it Notes™, Biodegradable Bags, Liquid Crystals, Soap, etc. Thirteen years of four issues a year has been put on CD with a handy search system. As with all CD-ROMs, reading from a screen is not as pleasant as reading from paper, but it is handy to have so much information on a little disk and to have the ability to search. One can also order back issues of the magazine, both the first five years and the second five years of the magazine are available for $30 each.

THE UTRECHT/ICASE SYMPOSIUM

June 3th - June 5th, 1998
Utrecht University, the Netherlands

The Utrecht/ICASE international symposium on science education will be held at Utrecht University as a follow-up to our very successful symposia at Dortmund University. Like the Dortmund Symposia, the Utrecht symposium will be organized in cooperation with the International Council of Associations for Science Education (ICASE).

The key theme of the conference will be:

Bridging the gap between theory and practice:
What research says to the science teacher

• The purpose of the conference is to bring together researchers from different countries to present and discuss new results in the field of education in chemistry, biology and physics.

• No conference fee will be charged. All participants are expected to obtain their supports by themselves.

• 40 minutes are allotted for the presentation of the paper, another 40 minutes for the discussion. The medium of the conference will be English.

• Invited lecturers include: George Bodner (USA), Diane Bunce (USA), Bao-tyan Hwang (Taiwan), Mercè Izquierda (Spain), John Oversby (UK), Arminda Pedrosa (Portugal), Iris Pigeot (Germany), and Hans-Jürgen Schmidt (Germany).

• ICASE have committed themselves to publish the contributions as proceedings. The abstract should be limited to 1 page (including references) and send in on diskette (and print) before September 30, 1997.

More information can be obtained from:

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Non-formal and In-formal Science Education

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This section focuses on the interface between non-formal, informal, and more traditional formal science education. Articles expose the world of out-of-school and public science experiences.

LINKING FORMAL AND INFORMAL SCIENCE EDUCATION THROUGH SCIENCE EDUCATION STANDARDS

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Abstract

This article introduces the National Science Education Standards and suggests that the Standards can be used as a mechanism for bridging formal and informal science education. Based on a review of the literature on student learning and educational effectiveness of science museums, specific science content from the Standards is outlined as potentially useful in informal settings for increasing student learning.

The National Science Education Standards

The release of the National Science Education Standards (NRC, 1996) was an important first step in identifying the goals for achieving scientific literacy for all Americans. The National Science Education Standards define the science content that all students should know and be able to do and provide guidelines to assess the degree to which students have learned that content. The Standards detail the teaching strategies, professional development, and support necessary to deliver high quality science education to all students in grades Kindergarten through grade 12. The document includes standards for:

- science content
- science teaching
- assessment in science
- professional development for teachers of science
- science education programs
- the science education system

The science content standards recommend less emphasis on the following:

- Knowing scientific facts and information
- Studying subject matter disciplines (physical science, life science, and earth science) for their own sake
- Separating science knowledge and science process
- Covering many science topics
- Implementing inquiry as a set of "process skills"

and more emphasis given to:

- Understanding scientific concepts and developing abilities of inquiry
- Learning subject matter disciplines in the context of inquiry, science and technology, science from personal and social perspectives, and the history and nature of science
- Integrating all aspects of science content (life science, physical science, and earth science)
- Studying a few fundamental science concepts
- Implementing inquiry as instructional strategies, abilities, and ideas to be learned

Bridging the Gap between Formal and Informal Science Learning

Achieving scientific literacy has become the national goal for education in many countries. Although admirable, the goal represents a challenge for the formal system of education. If nations are going to achieve scientific literacy, they will need to recognize the
importance of a combined effort of both the formal and informal education communities. In the words of Honeyman, "This is a time when we need to forge partnership between both formal and informal science education sectors." (Honeyman, 1996, p. 30). The position we present in this article is that the National Science Education Standards (NRC, 1996) represent an essential linkage for these two systems in the United States. People learn science from a variety of sources, for a variety of reasons, in a range of different ways (Wellington, 1990). These variables reflect earlier questions posed by Collins and Bodmer (1986) about the dynamics of science learning:

Do individuals get most of their understanding of science from school, from television, radio and newspapers, from their jobs, from leisure activities, from magazines and books, from museums and libraries, from special events designed to promote understanding of science? What is the balance between these sources for different segments of the public, and what should the balance be? (p. 103).

Outside the formal setting, science learning can take place in many environments including science centers and museums, natural history parks, geological sites, zoos, botanical gardens, and nature centers. Informal science learning is difficult to define, particularly when trying to determine its relationship to formal science learning. The literature identifies two frameworks for considering the relationship of formal and informal science learning. The first type draws a sharp dichotomy between formal and informal learning (Wellington, 1991). This approach, however, does not take into account the varied characteristics of informal learning, for example, visits to science museums can be voluntary or compulsory, structured or unstructured, integrated into the school science program or occasional, sequenced or unsequenced. The second type of framework is a hybrid approach, which includes both formal and informal learning (Crane et al., 1994):

Informal learning refers to activities that occur outside the school setting, are not developed primarily for school use, are not developed to be part of an ongoing school science curriculum. However, informal learning experiences may be structured to meet a stated set of objectives. Informal learning activities may also serve as a supplement to formal learning or even be used in schools or by teachers. (p. 3).

Hofstein and Rosenfeld (1994) adopted this hybrid approach to highlight the distinction between learning context and learning method. In the past, it was assumed that the compulsory school science context was tightly linked with formal learning methods. Hofstein and Rosenfeld suggested that this linkage is artificial and could also be harmful to the pedagogy of science teaching since what students learn in science cannot be limited to what is learned in schools. Thus, they suggest, learning contexts and learning methods should be mixed in order to provide a good blend of learning experiences. In particular, compulsory school contexts should include informal learning experiences.

What Influences Students Learning?

On the basis of syntheses compiled from thousands of research studies in education, Walberg (1991) suggested that the following model of nine constructs appears to increase learning:

Student aptitude
- ability, and prior achievement
- developmental stage
- motivation

Instruction
- the amount of time students are engaged in learning
- the quality of the instructional experiences

Psychological environments
- home
- school and classroom
- peer groups outside school
- media and other informal learning environments

By estimating the size of the contribution to learning of each element, Walberg found that ability, development, motivation, amount, and quality of instruction are essential for learning. It is suggested that both formal and informal settings contribute to, and influence the development of, these elements and thus will enhance learning overall.

The Educational Effectiveness of Science Centers and Museums

While recognizing science centers and museums potential for enhancing student motivation—a critical contributor to learning—this article focuses on the cognitive aspects of learning in these informal settings. The literature was reviewed with the following three key questions in mind:
• What do students learn from science museums?
• What is the most effective context in which to conduct a visit to a science museum or center?
• What can science museums do to increase motivation to learn science and to expand the repertoire of instructional techniques?

Learning and Time on Task Increase With Interactive Exhibits in Museums

Laetsch, Diamond, Gottfried and Rosenfeld (1980) asserted that about twenty million students\(^1\) took field trips to science centers, museums, and other informal learning environments each year in the United States. Often, these visits occur without much consideration as to why and how they should be conducted. In the past, the question of what students will learn from a visit to a science museum was rarely posed (Koran & Baker, 1979). Many of the studies focused on the affective components of the visit namely, the interests in and attitudes toward the science museum in general and certain exhibits in particular. For example, Atkin stated, “The goal of museums at that time was to fascinate, stimulate interest, and evoke feeling of wonder. The focus was on the dramatic and visual.” (Atkin & Atkin, 1989).

However, in the last 20 years, with the expansion of our knowledge of how students learn, and how to effectively assess this learning, and the increase in research supporting constructivist models of learning, there has been more interest in studying learner behavior in a nontraditional museum-type setting (Kubota & Olstad, 1991). A review of six studies (summarized by Falk, 1983) suggests that significant cognitive learning of science can and frequently does occur during museum visits. Falk also reported that scientific knowledge acquired on a field trip may be remembered for a long period of time.

Beier and McRobbie (1992), in Australia, found that students developed an understanding of the concept of sound via a hands-on investigation in an interactive science museum. They also found that students who already had an understanding (prior knowledge) of the

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1 A current best estimate of student services (including taking field trips, outreach programs, and school enrichment programs) extrapolated from data in Invisible Infrastructure by Inverness Research Associates, and from interviews with selected museums and other informal science institutions is computed to be closer to, or even exceed 70 million. This calculation is based on the estimated number of informal science learning centers hosting field trips (967), a range of attendance figures for field trips from 10,000 to 400,000, and a knowledgeable estimate of an average of 75,000 school children annually per site.

concept of sound as a vibration or wave were most likely to have major changes in their level of understanding.

In the United States, a series of studies based on behavioral psychology was conducted by Fehr and Rice (1988) and Fehr (1990) in California. Their work focused on the concept of light, i.e., vision, image formation, shadow formation, and color. They found that meaningful learning occurred when the students were engaged in hands-on activities with interactive exhibits. These findings support previous research by Screven (1975) who found that the more interactive the exhibit is the greater the attraction and holding power (time spent near the exhibit), and the greater the cognitive gain.

In their investigation of learning at the Lawrence Hall of Science, Their and Lynn (1976) found that interactive exhibits were better at fostering scientific reasoning skills than were more passive exhibits. Visitors are able to test their understanding of ideas as they interact with phenomena and with each other in hands-on exhibits and program activities in science centers (Honeyman, 1996).

In summary, the literature reviewed found that there is a direct and positive relationship between the interactivity of an exhibit, the time spent near the exhibit, and the amount of learning that will result. (See also Falk, 1983; Koran et al., 1986; Boisevert & Siez, 1995; and a comprehensive review of 20 research studies conducted by McLaugherty & Rennie, 1992). However, while some important insights have been gained from these studies, the literature on museum learning remains scarce due to the difficulty of identifying, isolating, and controlling the relevant variables which impact informal science learning.

Reducing Contextual and Cognitive “Novelty” Increases Learning

The question of when and in what context the visit to the museum visit is conducted relates to studies by Falk and Balling (1982), and Kubota and Olstad (1991), in which they discuss the psychological aspect of informal events. They refer to this phenomena as environmental novelty. They found that due to the novelty of an informal event or environment, students did not learn expected concepts. These studies demonstrated that the ability of students to conduct activities during field trips depends on their familiarity with the field trip setting. When the novelty was reduced through vicarious exposure (i.e., slide show presentation) to the site, the field trip was more educationally effective (Kubota, 1985).
Orion and Hofstein (1994) suggested that the novelty of the environment consists of three factors: 1) the cognitive novelty, i.e., experience with the concepts and skills which students will deal with during the informal event; 2) geographical novelty, i.e., acquaintance with the new environment; and 3) psychological novelty, i.e., experiences with out-of-school events. The most important factor for this discussion is the cognitive novelty.

It is suggested that that familiarity with the scientific concept underlying the exhibit will reduce the cognitive novelty of the visit (McLafferty & Rennie, 1992; Finson & Enchos, 1987; Orion & Hofstein, 1994). This is, in fact, a call for integrating the visit to museums or science centers with current and previous experiences in school science. Providing students with relevant material prior to the visit will enhance cognitive experiences on the site and increase understanding of the relevant scientific concepts.

In summary, when the informal setting is familiar to students and when tasks at the exhibit are clear, structured, and related students' experiences in formal settings, the informal learning experience can be extremely effective.

Science Centers Motivate Learning Through Varied Experiences

In the teaching of science, curriculum material and instructional strategies should be tailored to the abilities and aptitudes of different students. The overall objective is to create a learning environment which allows students to interact physically and intellectually with instructional materials through hands-on experiences and through minds-on and inquiry-oriented activities. A recent review (Walberg & Hofstein, 1994) presented evidence that instructional techniques in science should be matched to the learners characteristics and needs in order to maximize the effectiveness of the teaching and learning process. These findings call for varying the instructional techniques utilized in science education. In this context, the contribution of science museums should not be overlooked. Science museums could provide a significant component to the wide repertoire of learning modes and instructional techniques used in science education. Educators capitalizing on the thematic, interactive exhibits, the demonstrations, or the discovery-focused labs might concur with Screven (1987) that:

Informal learning in museums and science centers involves a different set of conditions than learning in schools . . . in general terms museum environments are better suited to effectively communicate general notions about science as a process, new ways to look at and to think about things, ways to explore, discover, ask questions, learning that simple things can be complex and complex things can be simple, learning to learn, learning that learning can be fun, that science can be fun, and perhaps most important of all, stimulating greater self-confidence with science topics and activities.

It is also suggested that using informal events in the context of school science will fit nicely with Walberg's model for increased learning. His model includes the amount of instruction, the quality of instruction, as well as in-school and out-of-school learning environments. These constructs, according to Walberg, will also enhance students motivation to learn science. Wellington (1991) suggests that the first step in the development of scientific literacy is to raise students motivation. Science museums should be considered a partner in this endeavor. Screven (1987) addresses the issue of motivation and notes that learning experiences in informal science settings are different than school-based learning.

It is likely that museums are better suited to improve motivation and attitudes toward science and providing frames of reference for dealing with science topics . . . (in museums) learners are mostly voluntary. What learning takes place is self-paced, self-directed, nonlinear, visually oriented, and motivated mainly by intrinsic interests like curiosity, exploration, manipulation, fantasy, task completion, and social interaction . . . the informal environment requires approaches that are different from what you can get away with in schools. More emphasis must be given to the intrinsic motivations of visitors that can insure attention, effort, and proper exhibit usage. Freedom of choice and movement must be maintained.

Many informal science institutions have taken the step to link with schools and to build relationships grounded on the National Science Education Standards. To enlarge the picture, making this a reality in all communities, requires teachers and informal science institutions to "construct the bridge" between formal school learning and informal science learning. To achieve increased science learning both partners should meet to consider the following:
• varying the context of learning, i.e., including some informal experiences within the formal education program,
• actively involving students in the learning experiences, i.e., hands-on and minds-on activities,
• familiarizing students to the setting, i.e., reduced environmental novelty or time to adapt to the new setting,
• varying the instructional techniques, i.e., an instructional model with different strategies used
• capitalizing on intrinsic student motivation to learn

In summary, informal science education settings, as science-rich, experiential, learning-contexts, can complement and serve schools in achieving the full potential of science education as envisioned by the National Science Education Standards. The following discussion explores additional strategies for achieving a comprehensive formal-informal relationship, recognizing and encouraging other opportunities that might arise.

Using Content Standards in Science Museums and Science Centers

The content standards in the National Science Education Standards elaborate what students should know and be able to do as a result of their educational experience (Bybee, 1997a, 1997b). In general, these standards state that as a result of inquiry-oriented activities, students should develop an understanding of fundamental concepts and abilities. We suggest, that in order to link formal and informal science education, the content standards guide both the teachers in establishing learning outcomes for field trips and the exhibit designer or educator in creating exhibits and programs. The following content standards may be of particular interest to informal educators: science as inquiry; science and technology; science in personal and social perspectives, and history and nature of science.

Science as inquiry

Science as inquiry is an essential component of scientific literacy and subsequently of school science programs. It includes abilities necessary to do scientific inquiry, and understandings about scientific inquiry in all three grade levels (K-4, 5-8, 9-12). As a result of their science studies, students will be able to ask questions, plan and conduct scientific investigations, think critically, construct and analyze alternative explanations, and communicate scientific arguments. The essential outcomes of science as inquiry include cognitive abilities using logic and evidence in formulating and revising scientific explanations, recognizing and analyzing alternatives models, and communicating and defending scientific arguments (Bybee, 1997a, 1997b). This vision of science education calls for dramatic change in school science teaching. Yet, in some science museums and in science centers, inquiry happens every day and thus could constitute a valuable resource to complement formal science education. The Exploratorium in San Francisco is such a science center (Oppenheimer, 1975).

Science and technology

In recent years, the integration of science with its respective technological applications has become an important component in science education. In the Standards, the similarities and differences between science and technology are clarified to include: the development of students abilities associated with technological design and the understanding of science and technology. The Standards provide students with opportunities to develop decision making abilities regarding science concepts and its technological applications in a societal and personal context. Museums that integrate science with technology, for example, the Museum of Science and Industry in Chicago, could contribute significantly to students understanding and abilities. The main achievements of these centers for science and technology have been to relate science and its technological applications to the objects that people see and use in every day life.

Science in personal and social perspective

A contemporary vision of scientific literacy includes connections between scientific knowledge necessary for decisions students and adults make about personal and social issues. For example, the content standards for science in personal and social perspectives for grades 9-12 includes the following knowledge and understanding:

• personal and community health
• population growth
• natural resources
• environmental quality
• natural and human-induced hazards
• science and technology in local national and global changes

It is suggested that these abilities and knowledge will help students fulfill their obligations as future citizens both socially as well as personally. The Human Body Discovery Space (HBDS), in Boston's Museum of Science, contains a variety of interactive exhibits on topics related to human biology and medicine. This
museum includes exhibits on cholesterol, human growth, match calcium content food, medicinal herbs, examples of fat content food, amount of blood in ones body, pulse and electrocardiogram, senses, insulin and glucose control and clinical chemistry (Boisvert & Slez, 1995). These are fairly complicated issues to be introduced in the formal setting of science education and the contribution of the museum in this area should not be overlooked.

**History and the nature of science**

Contemporary science developed from its history and advanced knowledge through established rules of conduct, such as using empirical evidence, applying logical arguments and allowing skeptical criticism. The content standards on history and nature of science presents science as a human endeavor: the limitations of science, the contribution of individuals to our current scientific knowledge, the interactions and interdependencies between science and society, and the fact that science is fundamentally a human enterprise. There is no doubt that science museums can play a significant role in illuminating these aspects.

**Summary**

In this article we have suggested that science museums and centers play an important role in reinforcing some of the goals of the National Science Education Standards. The Standards could help science museums and centers in strengthening their roles and relationships with schools and teachers within their local communities and in helping to increase students’ achievement in science. Recently, there has been a constant call for bridging the gap between formal and informal science education. We suggest that the National Science Education Standards could provide a solid and reliable bridge to connect this two entities.

**References**


CEFIC—THE EUROPEAN CHEMICAL INDUSTRY COUNCIL ON THE INTERNET WORLD WIDE WEB

Brussels, 10 July 1997—CEFIC has been developing its own home page and site on the Internet for quite a while. It feels it would now be useful to alert Journalists and all those interested in the chemical industries’ activities on the international scene, about access to CEFIC through the Internet World Wide Web.

http://www.cefic.be/

JUST TRY IT AND SEE FOR YOURSELF!

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LINKS WITH MEMBERS, ETC.

The CEFIC Internet site is being regularly updated and extended.

Later this year, a “CEFIC PRESS ROOM” will be created where the Press Releases, upcoming Press Meetings, European Press Officers Directory etc. will be grouped into one chapter on the CEFIC site.

Should you wish to receive press information electronically, please send your e-mail address to Marc Devisscher.

For further information and/or suggestions:

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December 5-8, 1997
Australian Joint Regional GASAT and IOSTE Conference
Curtin University, Bentley, Western Australia

This conference will bring together a wide range of practitioners and researchers working in the areas of gender, science and technology education. Expressions of interest in attending and/or presenting a paper are called for. Flexible modes of presentation are encouraged. Abstracts and early bird registrations are due August 31, 1997.

For more information, please contact:
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December 6, 1997
Chemical Modelling Conference
Bulmershe Court, University of Reading

The Modelling in Science and Technology Research in Education Group (MISTRE) is an international group of teachers and university tutors investigating the role of models in science and technology education.

The Chemical Modelling Group is part of the MISTRE Group focusing on how models are used in the teaching and learning of chemistry. Membership is open to anyone who wishes to contribute and share in its work.

Workshops
The workshops will explore delegates' own understandings of each theme. They will also include informed input on each theme, based on the range of models available and the sorts of models used in teaching in schools.

Discovering models
This interactive session will cover some practical methods of studying models in typical classrooms. Delegates should then be able to use some of these methods to carry out research with their own classes.

For more information, please contact:
Dr. John Oversby
University of Reading
Bulmershe Court
Earley
Reading RG6 1HY
Phone: (0734)875123
Fax: (0734) 318650

May 2-10, 1998
National Science Week 1998

The theme for schools will be: Oceans

July 5-10, 1998
CONASTA 47
Northern Territory University, Darwin

Science Education—Beyond the Horizon

The 1998 conference will be hosted by the Science Teachers Association of the Northern Territory (STANT Inc.). The conference is designed to provide a forum where all science educators; whether in primary, secondary, senior secondary or teacher education, have an opportunity to reflect and examine the important issues confronting education today and in the future. Issues of a geographical, cultural, political and technological nature centering on student learning will feature throughout the conference program. The sub-themes will give all interested in science education the opportunity to reflect on their practices and gain insight into what is waiting for us "beyond the horizon."

It is planned that prominent Australian and international educators, as well as experienced and enthusiastic classroom teachers will provide a stimulating environment where keynote addresses, seminars, workshops, discussion groups, forums and excursions allow professional enlightenment.

Further details are available from the conference website at:
http://www.topend.com.au/~stant/conasta.htm or write to:
CONASTA 47 Secretariat
PO Box 778
Nightcliff
Northern Territory 0814 AUSTRALIA
January 8-10, 1998
Enhancing the Teaching of Science
The Association for Science Education (ASE) Annual Meeting
The University of Liverpool, U.K.

- 280 Talks and Workshops
- 300 Exhibitors
- 90 Courses
- 40 Science Lectures
- 10 Social Events
- 20 Visits

For more information, please contact:
Conference Office
ASE, College Lane
Hatfield, AL10 9AA
Fax: 01707 266532
E-mail: ase@asehq.telme.com

March, 1998
Science & Society: Technological Turn
An International Conference on STS
Japan

Topics to be discussed include the following:
- Network assessment of science
- Transnationalization of Corporate Science
- Technology and Media
- International Relation in the Post-Nuclear Age
- Science and Technology in Asia
- Implication of STS on Science Education, Science Education Policy and Human Resource

Among the invited speakers are: Michel Callon, Sheila Jasanoﬀ, Deepak Kumar, Morris Low, Brian Martin, Arie Rip, Rustum Roy, Song Sang-Youg, Peter Weingart, and Robert Yager.

For more information, please contact:
Conference Office
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Graduate School of Information Systems
University of Electro-communications
1-5-1, Chofugaoka
Chofu, Tokyo 182 JAPAN
Fax: +81-424-85-9843
E-mail: sts@kob.is.ucc.ac.jp
http://hostcinf.shinshu-u.ac.jp/stsconfjp.html

June 3-5, 1998
THE UTRECHT/ICASE SYMPOSIUM
Utrecht University, the Netherlands

The Utrecht/ICASE international symposium on science education will be held at Utrecht University as a follow-up to our very successful symposia at Dortmund University. Like the Dortmund Symposia, the Utrecht symposium will be organized in cooperation with the International Council of Associations for Science Education (ICASE).

The key theme of the conference will be:
Bridging the gap between theory and practice:
What research says to the science teacher

For more information, please contact:
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July 25-28, 1998
Making Curricular Connections in the K-8 Classroom
Summer Institute jointly sponsored by the National Science Teachers Association and National Council for the Social Studies
Northern Arizona University
Flagstaff, Arizona

Join teacher leaders in this unique participatory institute on curricular integration featuring science and social studies. Working sessions based on presentations by nationally-known experts will provide opportunities for dialogue and application. Topics for exploration include: multiple intelligences, standards-based practices, service learning, performance-based assessment, thematic instruction, project-based learning, planning and managing integration, issues oriented learning, and literature connection.

For more information, please contact:
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Conventions Department
Conference Department
1840 Wilson Blvd
3501 Neward St., NW
Arlington, VA 22201-3000
Washington, DC 20016
703-243-7100, ext. 227
800-296-7840, ext. 108
conventions@nsta.org
conference@ncss.org
www.nsta.org
www.ncss.org
February 26-28, 1998
International Consortium for Research in Science and Mathematics Education (ICRSME)
7th Consultation
St. Clair, Trinidad

The International Consortium for Research in Science and Mathematics Education (ICRSME) is holding the 7th International Consultation from February 26 - February 28, 1998 in St. Clair, Trinidad. St. Clair is in the Port of Spain metropolitan area. The meeting will be co-hosted by the science and mathematics education community of Trinidad & Tobago and The Ohio State University represented by Donna Berlin and Arthur White in Columbus, Ohio. The program will provide opportunities to share favorite ideas and programs, make new friends and renew old friendships, get some much needed vacation time, pick up some new ideas and refine some collaborative research and development projects.

For additional information please contact either:
Dr. Arthur L. White or Dr. Donna F. Berlin
Math, Science, & Technology Education (MSAT)
238 Arps Hall
The Ohio State University
1945 North High Street
Columbus, Ohio 43210-1015 USA

March 23-26, 1998
International Conference for Environmental Educators
Pretoria, South Africa

Vista University and the University of South Africa (UNISA) would like to extend an invitation to educators to attend this international conference for environmental educators. The conference seeks to discuss the holistic role of environmental educators at universities, colleges of education, non-governmental organisations as well as those in business and industry.

Theme
There has been a growing realisation that environmental problems cannot be solved without keeping social, economic and political aspects in mind. The contrast between the so-called western and pre-modern worlds, often referred to as the first and third worlds, was highlighted during the Earth Summit in Rio. It is essential that these “worlds” work together to address environmental problems. Environmental educators at post-school level need to adjust their education programmes to address EE in both worlds and so work towards a global solution. The conference aims to discuss the role of these educators and to seek answers to questions such as: Are there different approaches to

EE in western and pre-modern worlds? How could strategies be co-ordinated to both?

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E-mail: DBEER-JJ@acaleph.vista.ac.za

NSTA Conventions: (More details to come.)
April 16-19, 1998
National Convention in Las Vegas, Nevada

March 25-28, 1999
National Convention in Boston, Massachusetts

April 6-9, 2000
National Convention in Orlando, Florida

March 22-25, 2001
National Convention in St. Louis, Missouri

1999
The 11th ICASE Asian Symposium
the Philippines

For more information, please contact:
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P TRI Building, Gen. Santos Avenue
Bicutan, Taguig
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Fax: 63 2 837 1924

May 17-21, 1999
National Science Week 1999

The theme for schools: Time

July 4-9, 1999
CONASTA 48
Adelaide, South Australia

Theme: The spirit of science

August 1999
IOSTE/GASAT Conference
Durban, South Africa
(More details to come.)
Extending and Improving Education in Science for All Children and Youth by Assisting Member Associations Throughout the World

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ICASE Homepage: http://sunsite.anu.edu.au/icase
Science Education International is the Quarterly Journal of the International Council of Associations for Science Education. ICASE was established in 1973 to extend and improve education in science for all children and youth by assisting member associations throughout the world.

This journal provides a means for associations, institutions, centres, foundations, companies and individuals concerned with science education, to share perspectives, concerns, ideas, and information which will foster cooperative efforts to improve science education, and which will serve as a chronicle of the advancement of science education throughout the world.

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March 1 February
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September 1 August
December 1 November

ICASE News .................................................. 2
Feature Article ............................................. 7
Science Education Around the World ........... 12
Research on Curriculum, Teaching, and Learning ........................................ 17
Science Teacher Education and Leadership ........................................ 21
Non-formal and In-formal Science Education ........................................ 26
Book Review .................................................. 34
Calendar ....................................................... 38

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ICASE News

This section provides news for the information of member associations, institutions, centres, foundations and companies. The Executive Committee encourages members to reproduce this section in journals and newsletters to communicate this information to as many as possible.

Happy New Year

Third European Science Festival
Dr. Boris V. Boulybash
State Technical University of Nizhniy Novgorod
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Nizhniy Novgorod, 603 155, Russia
shein@cht.fci-nnov.ru

For the last two years (1996 and 1997) the educational project 'European Science Festival (Science of Europe in Language and Culture)' has been realized in Nizhniy Novgorod (Russia). The authors of the project want the key goal of the Festival to be the demonstration of the European cultural diversity through the diversity of the national visions of Nature. The Festival competitions and contests make the students and the teachers from secondary schools of three Russian regions acquaint with the 'great persons, great books and great ideas' of European science and demonstrate its sociocultural context.

The First Festival (Science of France in Language and Culture) was devoted to the 400-ds anniversary of R. Descart, the Second Festival (Science of Netherlands in Language and Culture) — to the 300-ds anniversary of the Great Embassy of Peter the First to the Netherlands. The Second Festival was sponsored by the Embassy of Netherlands in Russia. In the May of 1998, the Third European Science Festival is planned to be held; thematically we intend to deal with the Science of Germany and Russia in Language and Culture.

We are sure that our educational project promotes the students' interest in science development and science itself. Besides, we expect that the Festival will stimulate the students to participate in the dialogues between science and humanities. We are willing to establish contacts with foreign partners who are ready to participate in our project.

STL Science Teaching Materials

In response to the call to promote Scientific and Technological Literacy for all (STL), ICASE has seen its role to help teachers and has undertaken a number of initiatives. These will be reported at the ICASE General Assembly.

One initiative, ran over the last 2 years by ICASE, with the help of UNESCO, has been a number of regional, writing workshops on creating STL teaching materials. The materials created so far will be displayed at the ICASE General Assembly in Liverpool, January 1998.

ICASE is concerned that science curricula are changing around the world to meet the ever increasing developments in science and technology, but little attention is paid to helping teachers modify their approach in line with changing emphases. There is a growing realisation that before curricula change, teachers need to be helped to rethink the goals of science education and the impact of this on their teaching strategies. One way to do this is to develop teaching materials in line with developments, but to do this with teachers so that they can gain 'ownership' as they reflect on the change. The ICASE writing workshops have had this objective.

The materials developed are supplementary to the textbook and other teaching guidelines and can be used in the classroom at the discretion of the teacher. All the materials:
Research on Science Teaching and Learning

This is the latest ICASE publication with the proceedings of the 5th International Seminar held in the University of Dortmund, Germany June 1996. There are 15 research papers and discussion reports ranging from gender issues to students’ conceptions. Copies of this publication may be obtained from the ASE Bookselling Department, ASE, College Lane, Hatfield, AL10 9AA, UK. The price of the book is 15 dollars or 10 pounds plus 25% for postage and packing.

Declaration made by the President of ICASE

On behalf of delegates of the Second ICASE Latin American Symposium, Mar del Plata, Argentina, April 1997:

‘We, the participants of the Second ICASE Latin American Symposium, affirm:

• that science and technology education can have a profound impact on the individual as well as the society at large;
• that science and technology education can help students towards a better understanding of themselves and their environment; and
• that, in order to be fully effective, science and technology education must become more relevant to the local context, promoting an action perspective in relation to the needs and issues which impact on the quality of life at the individual and societal levels.

We call upon governments and educational organisations—formal and non-formal—to stimulate and support action which will lead to scientific and technological literacy for all across the Latin American region.’

Globalisation of Science Education Conference

The following represent excerpts from the ICASE President’s opening remarks at the Globalisation of Science Education Conference, Seoul, Republic of Korea, May 1997:

“One behalf of the International Council of Associations for Science Education, I welcome you to the International Conference on Science Education and the wonderful city of Seoul. The theme ‘Globalisation of Science Education: Moving toward worldwide science education standards’ is a timely one. It recognises the global nature of the challenges and issues...
that confront us as science educators. There are remarkable similarities in what needs to be done in our respective countries despite our different cultural identities. This conference highlights the fact that we are not alone as we seek to encourage changes and developments in educational policy and practice which will provide a science education relevant to all.

ICASE is a networking organisation with over 130 member science teacher associations and educational organisations around the world. The theme of this conference describes the very essence of ICASE as we work with our members and various international bodies around the world to develop a quality education in science for all. Therefore, it is with a great deal of pleasure that ICASE is co-sponsoring this event.

The task of improving science education for all, however, is a huge task and much needs to be done. The task can only be achieved through collaboration and partnerships. We need to find ways to mobilise and martial the resources, skills and talents of individuals and organisations, not just from the formal education sector, but also from non-formal agencies. This, too, is a particular focus of our agenda this week.

My thanks to the co-sponsors—the Ministry of Education, UNESCO and the Korean Min-Jok Leadership Academy—for their support of this important event. I would like to pay tribute to the Korean Educational Development Institute and its staff for their efforts and skills in organising this conference.”

ICASE Distinguished Service Award to Dr. Robert E. Yager

During the opening of the ‘Globalisation of Science Education’ Conference, Seoul, Republic of Korea, May 1997, Dr. Robert E. Yager was presented with the ICASE Distinguished Service Award by ICASE President, Brenton Honeyman.

“It is my very great privilege to acknowledge an individual who has been selected to receive the ICASE Distinguished Service Award—the highest ICASE award honouring the achievements of an individual in the field of international science education. This individual joins an illustrious group of science educators who have each made their own remarkable contributions to science education at an international level. I am pleased to announce that the 1996 ICASE Distinguished Service Award is to be awarded to Dr. Robert E. Yager.

Dr. Yager’s career as a science educator spans a period of more than 40 years—a period in which science education has been characterised by significant and far reaching changes and developments. Throughout this exciting period of re-defining science teaching and learning, Bob Yager has been a prominent figure in inspiring new thinking about how best to engage students in experiences of understanding science in the context of their everyday lives. It is his clear vision of science as it relates to technology and to society that has been the driving force underlying his outstanding efforts to promote science curriculum so that it moves out beyond textbooks and classrooms to connect with the demands and challenges that people face in the context of contemporary society.

The remarkable achievements of Dr. Yager, the Professor of Science Education at The University of Iowa, have been recognised by the conferral of many USA awards, including the Distinguished Service to Science Education award by the National Science Teachers Association, the Presidential Award by the National Science Supervisors Association, and the Governor’s Science Medal for Science Teaching. His high standing in the educational community has been recognised through his appointments and elections to prestigious US educational organisations and projects.

His talents and contributions are well known beyond his own country, however. He is in high demand as a speaker, contributor and consultant in many, many countries throughout the world. His prolific writings have been appreciated by countless students, teachers, researchers and administrators in many regions of the world, and have been a significant catalyst for change in educational practice—particularly in the area of STS (science-technology-society) education. It is a fitting tribute to the high international regard in which Dr. Yager is held, that he has been appointed as the organiser of this important conference on the theme of ‘Globalisation of Science Education: Moving Towards Worldwide Standards.’

In addition to acknowledging his extensive accomplishments, I would like to refer to his outstanding qualities as a person. Bob continues to be a source of inspiration to all of us involved in science education. Classroom teachers, teachers-in-training, educational researchers and administrators alike, through our contact with this man, have been encouraged and enriched as a result. His genuine interest in and commitment to facilitating the work of those involved in science education at all levels have left a special mark on all of us.
Therefore, it is with great pleasure that I present the 1996 ICASE Distinguished Service Award to Dr. Robert Yager in recognition of his outstanding contributions to international science education."

Professor Rosalind H. Driver (1941-1997)

Rosalind Driver died at home at 6.30 p.m. on Thursday 30 October 1997, as a result of her cancer.

Rosalind Driver became one of the most pre-eminent figures in science education of her generation. She was a major figure on both national and international stages who attracted considerable interest and respect from science education researchers and science teachers. Throughout her professional career she displayed an enduring passion towards science education and took very seriously the responsibility of trying to improve our understanding of what is involved in teaching and learning science and, indeed, what might constitute an education in science.

Educated at Nottingham High School for Girls, she went on to study at the University of Manchester where she gained an upper second in physics, a subject whose intellectual demands and rigour were always a source of great fascination and interest for her. It was at this time that she met her future husband, Geoff.

After completing her degree, there followed a period of several years teaching which ultimately led her to the University of Illinois to work with Jack Easley as a research assistant on a project examining the cognitive behaviour in children. It was this work that was to lead to her Ph.D., awarded in 1973, on the representation of conceptual frameworks in young adolescent science students.

Her thesis presented an argument that was radical at the time. Students everyday knowledge of natural phenomena was viewed as a coherent framework of ideas based on a commonsense interpretation of their experience in living in the world, rather than as misunderstandings or mistakes. These findings, published in an article in Studies in Science Education in 1978, were to offer a new language to describe children's thinking. No longer were their ideas naive notions but alternative frameworks or interpretative models. Furthermore, she argued against the dominance of the Piagetian stage theory of development. Instead, together with Easley, she proposed that children's cognitive development may be more like a series of Kuhnian paradigm shifts, new ideas about a phenomenon replacing older ones. She argued that children's learning was dependent upon existing ideas about a phenomenon, rather than being limited by a child's developmental stage. Through this work, Rosalind Driver became one of the main progenitors of the constructivist movement that was to dominate science education throughout the 1980s and into the 1990s.

In 1974 Rosalind Driver was appointed as a Lecturer in Physics and Science Education at the University of Leeds. Her interest in research soon led to an appointment as the senior research fellow (1977) and then Deputy Director (1979-82) of the Assessment of Performance in Science Unit (APU), a major research project to document student achievement in science during the years of compulsory secondary schooling in England and Wales.

However, her most influential work stems from her period as Director of the Children's Learning In Science Project (1982-1989) and the Children's Learning In Science Research Group (1990-1995). The CLIS Project, funded by the UK government, was established to investigate possible reasons for the poor performance of students in science that had been identified by the APU. The early work of CLIS drew upon work described in her seminal book, *The Pupil as Scientist?* (1983, Open University Press). For many teachers, this volume provided an introduction to the work of Ros Driver. Teachers changed their perceptions of children's learning, and started to respond to children's thinking more directly in their teaching. Moreover, written in a simple and clear style, the book was a reflection of Ros's view that research can often be of practical relevance to the classroom science teacher and underpin curriculum development. Consequently, it is no surprise that Ros Driver's name became so well known amongst science teachers in the UK (and elsewhere).

The work of the CLIS project was firmly based on a collaborative effort between CLIS researchers and science teachers from the West Yorkshire region. In developing the CLIS in the Classroom teaching materials as many as fifty teachers were involved in three working groups over a period of two years. Ros Driver was at the heart of the activity, always welcoming teachers to the university, always appreciative of their efforts, always intent on talking and thinking through how theory might inform classroom practice. Through this work teachers became involved in reflecting on their own practice, in developing new teaching approaches, in attending conferences, in running workshops for
various audiences, in studying for higher degrees in education. Professionally, these were liberating and exciting times.

The work of the CLIS project led to many more important publications, in particular an edited volume (with Andree Tiberghien and Edith Guesne) aptly entitled *Children’s Ideas in Science* (1985, Open University Press), and further valuable packs for teacher professional development. By the mid-1980s, scholars from all over the world were beating a path to Leeds to work with Ros Driver and her colleagues. The standing of her work was recognised in 1986 by her appointment to a Readership, and then in 1989 when she was appointed as Professor of Science Education at Leeds. Her growing reputation led to a increasing number of appointments, in particular, to the UK National Science Curriculum Working Group, and a growing number of invitations to present her work, both nationally and internationally. In 1995, she was appointed Professor of Science Education at King’s College London, following the retirement of Paul Black.

In a very real sense Ros Driver saw research as a team enterprise and was always keen to encourage and support those that she worked with. The delight of working with Ros was the sheer passion and enthusiasm that she brought to whatever project she was working on. Endowed with the gift of being not only an eloquent speaker, but also a good listener, she took an avid interest in colleagues ideas and work, always willing to argue the point, but always offering the reassuring support so vital to sustain research work through the many dark hours and difficult periods. Moreover, she led by example a positive maelstrom of energy and hard work that carried those who worked with her in its wake, gaining their highest respect and commitment. It was also this interest in her colleagues, both in the UK and abroad, that led to a wide national and international network of friends and colleagues. A Canadian colleague recently wrote of what she had learnt from Ros’s work: “when I read her writings or when I listen to her talk, I learn a way of being, a way of doing research, of talking about it and a way of talking to people. . . .”

Ros was instrumental in working with science educators in Europe to establish the European Science Education Research Association (ESERA). The Association, inaugurated at the European Conference on Research in Science Education held at Leeds in April 1995, now holds a biennial conference which alternates with a summer school for Ph.D. students in science education. She was delighted to be able to attend the First Conference of the Association in Rome, two months before she died, and once again to meet and discuss her work with many old friends.

During the 1990s, the focus of Ros Driver’s work shifted towards explaining progression in conceptual understanding through cross-sectional studies. In addition, students conceptions of the nature of science and promoting scientific literacy became more prominent in her work and she extended the scope of her work to look at students learning of science at the undergraduate level. A feature of Ros’s approach to research was a willingness to develop and extend her own theoretical perspectives, recognising issues not addressed in earlier work, rather than defending an existing position for the sake of it. She was the lead author of a number of influential publications in science education such as Constructing Scientific Knowledge in the Classroom (Educational Researcher, 1994) and Young People’s Images of Science (Open University Press, 1996).

Whilst at King’s College, even though troubled by the onset of cancer, she succeeded in gaining funding for a series of seminars to explore the shape of the future science curriculum with leading science educators in the UK; a proposal to investigate pupils’ and parents views about the science curriculum, and in August heard that she had been successful in a proposal to explore and develop the skills of argumentation in school science. A crowning moment in her career was the award this year by the National Association for Research in Science Teaching (NARST) in Chicago of the plaque and citation for Distinguished Service to Research in Science Education. Those of us who were there will remember the enthusiastic standing ovation that this well-deserved award received from the science education research community.

If we are to be judged by what we leave behind for future generations then Ros Driver’s work in changing our understanding of what it means to teach and learn science must be regarded as a considerable and enduring contribution. For those of us that knew her professionally, her death prompts particular sadness in that she still had so much to offer. We shall all miss Ros’s energy and enthusiasm, her scholarly interests and wisdom. We shall miss her warmth, humanity and friendship.

Ros is survived by Geoff Driver, her husband of 34 years, and her son, Robert.
Feature Article

EXCAVATING SCIENCE EDUCATION: SOME REFLECTIONS FROM ARCHAEOLOGY

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Abstract

Adopting an archaeological perspective may be fruitful when examining the historical remnants, pillars, and foundational basis for much of current thought and practice in science education. The process of attempting to uncover the past and trace early forms of current science education involves the collection of both intellectual and physical evidence and is not unlike the archaeologist’s quest to more fully understand the nature, scope, and belief systems of ancient civilizations. In a Kuhnian sense (1970), the mental and physical strata of previous civilizations correspond to paradigmatic shifts in science education which are useful in characterizing the level and movement of science education thought in western society. Several incongruent features and practices, referred to here as Science Education Artifacts (SEAs), identified from this archaeological stance, are discussed in light of a more authentic and alternate conception of scientific practice. In order to treat the identified SEAs as true historical relics, all traces of their persistence in current science teaching practice will have to be eradicated.

Introduction

The inspiration for this paper came during a visit to several antiquity sites and ancient ruins in Western Turkey, the location of two of the seven wonders of the ancient world. While it is hard to isolate a particular moment in time when the idea for viewing science education form an archaeological stance actually occurred, it was definitely there as my wife and I wandered about the ancient acropolis of Pergamum overlooking the Aegean Coast. Active excavation is ongoing at Pergamum under the supervision of an Italian team and much of the large, open amphitheater, the impressive library, which rivaled that of Alexandria, the agora, and some main features of the main temple have been restored. The technology behind the piped in, gravity powered, water system from higher sources several kilometers away rivals that used in nearby villages today. Still much is left to one’s imagination of what the city must have been like during the first century A.D. Similar feelings abounded as we toured other sites of antiquity: Troy (Troas), Heliopolis, and the far more extensive excavations at Ephesus, begun over a century ago.

At such places, it is difficult not to reflect on what life must have been like during the height of grandeur of these ancient past civilizations and what little really remains today for observers to base their opinions on? What valid insights can one actually extract, from such ruins—the miscellaneous relics, columns, and limited artifacts that have survived the pillages, archaeological expeditions, lootings, and, (probably more significantly) the major earthquakes that have occurred over millennia? In many ways our insights into the daily life and the nature of civilization in ancient times comes about only partially from the physical evidence one encounters directly or from those on display in archives and museums. Major understandings are also a function of the knowledge, practices, beliefs and values that have withstood the ravages of time and humankind. These are the more enduring qualities of past civilizations that lie at the essence of the particular society which have contributed so much to the overall betterment of humankind.

I believe the archaeological metaphor is an apt one when examining the historical layers and foundational bases underlying much of current thought and practice in science education. This process of attempting to uncover the past nature and foundational basis of current science education, focuses more on mental fragments but the process is not unlike that of the archaeologist’s overall quest to more fully understand the nature, scope and belief system that characterizes ancient civilizations. In a Kuhnian sense (1970), the mental and physical strata of previous civilizations correspond to paradigmatic shifts in science education which are useful in characterizing the level and movement of science education thought in western society.
Learning About Science

Hodson (1994) makes a useful distinction in science education by identifying three major elements which make up the field:

1. **Learning science**, which refers to the acquisition and development of the conceptual and theoretical knowledge in science;

2. **Learning about science**, which is directed towards developing an understanding of the nature and methods of science, and an awareness of the complex interactions among science, technology, society and the environment; and

3. **Doing science**, which entails engaging in and developing specific disciplinary expertise in scientific inquiry and problem solving.

This paper is directly towards learning and teaching about science and how many of our pedagogical conceptions and assumptions about teaching and learning have changed dramatically over time. Indeed the contention is that, for the field of science education in general, changes in practice have been profound. So much so, that, even assuming an archeological stance, the science educator of today is hard pressed to even recognize or to be able to uncover the essential remnants and basic structural foundations of current constructions in science education. On the other hand, there is distressing evidence that for some science teachers, little or no fundamental change has occurred in learning and teaching about science over the years. Hopefully, those who tend to be ‘methodologically bound’ to a more traditional science teaching position are both few in number and non-influential in effect. However, in the context of many lesser developed countries, there is considerable evidence to indicate that much of science education is still heavily influenced by an ‘older,’ outmoded transmissional view of teaching and learning. This traditional view only serves to perpetuate certain stereotypical and outdated views of how science works and what scientists actually do (Wheeler et al., 1992). These distortions are harmful for, in addition to grossly distorting the nature of science, they may well serve to turn off students from entering science related careers.

Consider the following passage taken from PSSC Physics:

It [physics] is like a great building under construction . . . some parts are pretty well complete, and both useful and beautiful, others are only half done. Still others are barely planned. New parts will be started and completed by the men and women of your generation, possibly by you and your classmates. Once in a while, a finished room in this structure known as physics is found unsafe, or no longer large enough for new discoveries, and the room is abandoned or rebuilt. *But the great foundations are well laid and stand on pretty firm ground. These remain unchanged though changes go on above them.* (1976, p. 3)

The implicit message in the above passage is indicative of what I am referring to as an ‘older’ view of science, one in which the overall objective of science is to finish constructing *the* building. While new rooms can be modified or added, little or no consideration is given to alternate designs for the structure, other possible venues for science to occur, the human face and texture of science, and the idiosyncratic, serendipitous, and often highly intuitive dimension of scientists. One gains the strong impression that the same architectural firm was successful in tendering for the construction of all science education building during the 1960’s and 1970’s! Other excavations in science education throughout this period yield strikingly similar foundational features.

Science Education Artefacts

There are several incongruent features or practices associated with learning and teaching about science which quality for entry into the permanent archival collection as legitimate ‘artefacts’ of science education. Some of these artefacts are easily excavated, others are far more difficult to uncover. All, however, are inconsistent or incompatible with more current conceptions of practice in science education.

**ONE—THE ‘BLANK SLATE’ ARTEFACT**

This incongruent feature or artefact refers to the heavy reliance placed on observation as an objective and reliable means to scientific knowledge. It often manifests itself as the oft-quoted phrase in the science classroom, “the mind is a tabula rasa” and assumes that scientific observations are truly independent from the observers and are reliable across different observers. It qualifies as a legitimate artefact in science education since it is now apparent that we filter and decode observations based on our previous experiences, prior knowledge base, beliefs, and expectations. Far from being ‘blank slates,’ our minds are laden with existing constructs which serve to accommodate, and assimilate incoming stimuli. Attaching meaning to these stimuli
is a complex and idiosyncratic process. For example, whether you see an elegant vase or two old men, or an old or young women in Figure 1 depends more on the brain’s interpretation of the incoming images than on any physical phenomenon. According to Barlex and Carre (1985) our existing conceptual framework plays a critical role in determining how and what we observe. “We do not see things as they are, we see things as we are.”

Figure 1. An elegant vase or two old men?

Interestingly, if the incoming stimuli are incompatible with our existing conceptual framework, the result may be an optical illusion (Figure 2). Here the effect is often a disturbing or irritating one as the image does not mesh well with our expectations.

Once changes occur to our mental constructs, they in turn affect future perceptions. Once you are first able to see the alternate images embedded in Figure 1 for example, you will experience little difficulty in discerning both images in the future. The point here is that nothing has changed in the incoming stimuli, hence the change must have taken place be in the observer and the way in which the world is now perceived. Hence it is important in science education to acknowledge the extent to which our perceptions are personally constructed and to teach students how to observe and interpret what they perceive.

Figure 2. Optional Illusional

TWO—THE ‘LAST BRICK’ ARTEFACT

The earlier reference comparing the process of science to the construction of a building is indicative of the ‘last brick’ artefact in science teaching and learning. Viewing science teaching and learning as ‘bricklaying’ accepts that science is a precise, and highly objective process. Presumably adherents to this position, believe that if the bricks are placed according to the architectural blueprints, the process will eventually lead to some ultimate truth when the last brick or cornerstone is set into place. Like Kuhn’s complacent period of normal science, only minor construction refinements or modifications are allowed to the overall structure. These only serve to house additional equipment or to provide additional space to carry on the expanding process. Like many ancient Roman and Greek buildings, classical houses of sciences were built for permanency and aesthetics. This ‘last brick’ artefact held great appeal for many as it appeared to lend a degree of credibility and authority, and hoped for longevity to the scientific community.

However, the study of archaeology is resplendent with the ruins of past civilizations who operated solely under this model of ‘normal science,’ unable to accommodate to the cracks in the building’s foundation, the inevitable unsolved and unexplained problems that accompany the constant growth of scientific knowledge.

As Kuhn (1970) reminds us, science does not proceed by consolidation alone, but through successive phases of revolution and consolidation, whereby established paradigms are superseded during ‘crisis’ periods by dramatic and revolutionary processes. Like the study of archaeology, excavations in science reveal discontinuous layers of conceptual thought over time.

Figure 3. Paradigm Shift

It is interesting to reflect on the degree of resiliency under Kuhn’s model of science in relation to the ‘science educator as archaeologist’ metaphor. Like the golden years of earlier civilizations, the life-span of a particular paradigm is measured largely by it tolerance for unexplained anomalies, and other refutational evidence
brought in by people of other emerging nations. If such incoming evidence is not critically damaging to the existing paradigm, the 'civilization' adjusts by modification and development to these incoming changes and pressures. If, however, incoming ideas prove insurmountable to existing thought, then science theories, like civilizations, may decline or be overthrown. These transitions can occur through either peaceful or revolutionary means. Theories are resilient because they can absorb or assimilate abnormalities in many ways. If they are not the case, science educators would have to be constantly shifting theoretical positions or paradigms. Kuhn has further argued that competing paradigms are often also incommensurate. That is, they involved different ideas and concepts or they use them in different ways. For example, consider concepts like time and space. These same words, used in a Newtonian sense, convey very different meaning when used in the context of the Einsteinium paradigm. Presumably this incommensurate feature applies in archaeology as well. That is, when attempting to ascribe meaning and value to certain precepts held by different people, the time period and development level attained by the culture, must be taken into consideration.

THREE—SEPARATE SHARD ARTEFACT

There is little doubt that considerable insight into past civilizations has been amassed through the meticulous and painstakingly slow process of attempting to fit the many pieces of the archaeological puzzle together. Clearly however, the archaeologist's skill and knowledge base about the nature and origin of the excavation under examination is instrumental in making sense of the many pieces of evidence, which frequently consists of small shards of pottery and glass. The interpretation and meaning however, placed on the many archaeological finds, are made possible because of the theoretical background and training of the professional archaeologist.

The 'separate shards' artefact in science teaching manifests itself when the processes of science, like observing, classifying, measuring, etc. are treated as if they were discrete, generic, and theory-independent processes. The separate shard approach does not recognize that it is impossible to engage in these processes independently of content. As in the 'blank slate' artefact, the manner in which one observes, classifies, hypothesizes depends largely on one's theoretical understanding. As noted by Hodson (1994),

... we are not teaching students to observe, classify, measure and hypothesize per se. They can already do that perfectly well. They have been doing so since long before they came to our science lessons, and continue to do so every day in their lives outside the laboratory.

What we are teaching them is a firm understanding of the scientific notion of these processes which are theory-specific. Scientific observation is theory—impregnated and all observations should be validated by reference to a theory base. To teach science by treating these processes as separate entities or shards of evidence is an artefact of science education which should be permanently laid to rest.

FOUR—'VALUE-FREE' SCIENCE ARTEFACT

The Kuhnian notion that science advances through a complex communal process whereby ideas of particular scientists eventually become accepted as scientific knowledge in itself negates the idea that science can ever be value free. It is the psychological, emotional, and political turmoil that scientists engage in that eventually give rise to paradigmatic shifts. These factors, also impact on a wider scientific community. Hence simplistic accounts of theory acceptance and rejection, found in many earlier science textbooks, do injustices to both students of science and what they read about scientists themselves.

Summary

This paper examined certain parallels that appear to exist between the field of archaeology and science education in an attempt to identify outdated features in the study of the teaching and learning of science. Any analogy of teaching and learning unavoidably encompasses some oversimplification and is unlikely to take into account all the complexities involved in the teaching and learning process. However, the science education artefacts presented here are reflective of earlier eras which gave rise to them. Ironically, in spite of their inapplicability to current practice in science education, it is evident that such artefacts are highly resilient and can still be found in many science classrooms today. Hence, before they can be treated as true historical artefacts, total classroom eradication would have to be assured.

In summary, it is important to remember that all archaeological artefacts are, by definition, a result of human endeavor, and hence reflect both human achievement and fragility. In the context of science education, we often forget this human aspect, and the extent to which all science is a result of human activity, built up over centuries by the views, attitudes and prejudices of real people.
References


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Call for Papers for the Second China-U.S. Conference on Education


If you are interested in expanding our professional network and interacting with counterparts in the People’s Republic of China we invite you to submit a paper or to attend as an interactive participant.

The Steering Committee invites papers for presentation at concurrent and poster sessions. Applicants must address one of the following topics:

QUALITY OF PERSONNEL: Preparation and development of administrators, teachers, or teacher trainers, leadership, professional standards and responsibilities, teacher/student relationships, and personal characteristics.

QUALITY OF STUDENTS: Preparation of students to live successfully in their local and in the global community, required knowledge and information base, assessment and personal characteristics.

QUALITY OF PARENTING: Preparation for the parenting role, recognition of parents as first and life long teachers, building school/home relationships, parents as school partners, and personal characteristics.

QUALITY OF CURRICULUM: Preparation, selection, and integration of new curriculum, elimination of irrelevant and outmoded subject matter, required technology and training, integration of curriculum, and assessment.

Papers must not exceed one page double spaced, using 10 point pitch.

Include:
- presenter’s name
- title
- organization/institution
- mailing address (including 9-digit zip code)
- phone number, fax number, and e-mail address
- grade level - K-12, college/university

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SCIENCE EDUCATION DEVELOPMENTS IN TURKEY

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General History of Turkey

Before coming to Anatolia (Asia Minor), many of the Turkish people were newly converted to Islamic religion from their native religion (Shamanism). By the 13th century, most parts of Anatolia were colonized by Turkish people and in 1299, they established the Ottoman Empire lasting more than 650 years. The Ottoman Empire collapsed in 1922. The educational system of the early Ottoman Empire was composed primarily of religious schools supported by the Ministry of Religion. In addition to these religious schools, which were affiliated with the Mosques, there were a few palace schools designed to prepare the state-men. However, in 1839, as a result of western influence, the first major system-wide change in the educational system occurred. With proclamation of the Republic of Turkey in 1923, the national educational system was expanded to include military and technical schools and more closely emulated school systems in European countries. For example, all educational institutions were brought under one umbrella by the Unification of Education Law passed in 1926. As a result of this law, still effective today, duality was eliminated and replaced with a more western and secular system (Cahill, 1984).

Turkey has an area of 780,576 sq. km. and geographically forms a bridge between Europe and Asia. According to 1997 statistics, the population is almost 63 million, 99.8% of which are Muslim and the remaining two tenths of one percent are composed of ethnic minorities, such as Jews and Christians. The workforce is dominated by agricultural related jobs, but is decreasing every year, and being replaced by industrial and service sector positions. The World Bank classifies Turkey as a half-industrialized developing country (growth rate approximately 8% per year). The per capita income in 1995 was around 3,000 US dollars (OECD, 1995).

Educational Developments After 1923

According to Ayas, et al. (1993), the Turkish Science education developments after 1923 can be divided into two phases—before 1960 and after 1960. In recent years, it has been difficult to see stable governments in Turkey and this causes changes in the educational system every three or four years. However, the early Turkish education system showed the most stable period and shaped the education system. During these years, many famous foreign educators, such as John Dewey, Kuhne, and Omer Buyse, etc., were invited to Turkey (Basgoz & Wilson, 1968). Their findings were discussed by Turkish educators and many of their suggestions were applied. The most influential foreign educator was John Dewey whose comments directed Turkish educators to prepare their own curricula based on Turkey’s needs. During the 1950’s, aims and objectives of Turkish education system were revisited again with the primary goal of increasing literacy and reaching out to everyone in the country. Especially in the elementary science curriculum, the basic focus was to teach basic science concepts and make elementary pupils understand and find connections in their daily life via science courses. However, it is difficult to say the same thing for middle school and high school science curricula. In fact, how these objectives were accomplished is not clear. Despite foreign educators’ suggestions, the science curriculum continued to use textbooks as a source of science curriculum and did very little to meet regional and local needs.
After 1960

There has been a world-wide deviation to science education starting in the late 1950's. One contributing fact was the technological competition between West and East during the cold war era. When Russia launched the first space craft, it focused its attention on science education, especially in the USA. This led to the formation of new USA science curricula, such as PSSC, the CHEM study, and BSSC in the USA. The effects of these new curricula innovations influenced Turkish science education curricula, but it did not go beyond simple translation of these curricula. These translated versions were made available, but the new American curriculum implementation was not totally successful throughout the country. In fact, the Ministry of National Education of Turkey (MEB) and the Turkish Scientific and Technical Research Institute (TUBITAK) made a great effort to adapt the new science curricula, such as opening a science lab classroom for every secondary school complete with local supplies.

Although the Turkish education system has been centralized since 1925, these imported curricula created a dichotomy in the nation’s schools. Many continued to use the so-called classical science curricula while other secondary schools were implementing the modern science curricula (BSSC, the CHEM study, etc.). This dual system in secondary science education continued until 1985. Finally, in that year these translated and adapted science programs were mandated by the Ministry of Education (MEB, 1985; Turgut & Pekgoz, 1976; Turgut, 1990), but continued to fall short of the need for educational reform.

Here are some points why these science curricula were not successful in Turkey. First of all, the American curricula were prepared for the USA, a technologically advanced country. There has been similar complaints concerning these curricula in other countries who also attempted to adopt and implement these curricula (Fensham, 1988). The Turkish education system and society were simply not ready for these curricula, especially the science teacher preparation component. Keep in mind that one of the most important aims of the Republic of Turkey has been to reach the level of the other westernized nations. After 60 years, perhaps physically Turkey appears to be a westernized country, but the same thing can not be said of their underlying philosophy and beliefs. Turkish society still depends upon traditions, religious customs, and strong family values, especially in rural areas. During the implementation of these curricula, teacher preparation both in service and pre service were ignored. For example, until 1975, elementary school teachers were prepared in Teacher Training Senior High Schools. Later, it was changed to two-year junior teachers’ college. High school and junior high school teachers were coming from three-year colleges, and a few from four-year university college programs. Also, during the 1970’s, wide-spread student unrest, especially in teaching institutions, slowed the integration of the adopted science curricula in those institutions (Turgut, 1990). Consequently, the majority of Turkish science teachers were not prepared to teach the new curricula. For instance, in the author’s high school physics course, the teacher was not capable of teaching the course or using the lab equipment. In addition, this imported curriculum was very difficult and because the material was written with another culture in mind, it was near impossible to find daily applications of the curriculum. To make things worse, the Turkish Scientific and Technical Research Council (TUBITAK) funded and cooperated with the Ministry of National Education, but withdrew its support in 1980, thus leaving the Ministry of National Education without the required funds, and technological and scientific supports needed for implementation (Turgut, 1990).

Other problems arose as a result of the translation process. When the curricula and textbooks were translated by Turkish science educators and scientists, a vocabulary problem surfaced because few scientific words of the Turkish language could not meet the scientific vocabulary of English language used in the textbooks. Thus, science educators and translators used the original English word or some other Turkish words previously used by students during their early education and having completely different meanings. The results of process confused students’ concept development and scientific understanding (Ayas, 1993).

The adopted biology curriculum received a great deal of attention by society, and voters mandated that politicians change the biology curriculum or remove some parts of the curriculum, especially in evolution sections found in the 11th-grade modern high school biology text book. Like in the Bible’s Old Testimony, the Quran, the holy book of the Islamic Religion, refers to creationism and mainstream Islamic philosophy states that “Man is created by the God as he is.” This controversy began in 1985 and resulted in a new high school biology curriculum prepared by a special curriculum committee including biology teachers from high schools, biology faculties from science colleges, and other curriculum specialists, and published in the official newspaper of the Ministry of National Education (Tebildir Dergisi) (MEB, 1985). This new high school biology curriculum covers creationism as well as Darwinian evolutionary theory. It was an effort to create peace between socio-religious values and scientific approaches. However, according to the National Basic
Education Law legislated and passed in 1973, one of the main aims of the Turkish education system is to have students gain scientific understanding. Supporters of this new curriculum surplant this mandate by claiming that creationism should be considered a theory just like the evolutionary theory.

As mentioned in the early part of this paper, since the 1960’s the major problem in the Turkish education system has been political stability because of changing governments and education ministers every two or three years. Many times, this results in unfinished attempted changes as each new education minister promotes a new agenda. For example, during the educational ministry of Avni Akyol in 1991, a new high school credit course system was created, only to be replaced with another system three years later by another minister of education, Nevzat Ayaz in 1994. Although these changes affect high school curricula including science, few of these changes are aligned with current worldwide accepted reform. Generally, these changes focus on course objectives and minor revisions. Therefore, the nature of high school science curricula in Turkey continues to reflect teacher centered programs, textbook and a heavy content base. From the students’ and teachers’ point, the purpose of science textbooks and curricula is to prepare students for higher education university entrance exams. For this reason, few see a need for science education to develop process skills or present concepts in their daily life. That is why many high school students see no practical value in these science courses except as preparation for the university entrance exams. There are three major goals for Turkish secondary science curricula. These include: 1) an understanding of scientific facts and principles for every citizen graduated from high school; 2) the development of good health habits; and 3) a basis of scientific knowledge and skills for university education (Cahill, 1984). It seems that science curriculum change efforts ignore especially the first goal.

**Primary Science Education Developments in Turkey**

Primary education, or basic education, refers to K through 8 grades in Turkey. Until recently, primary education was under three different school systems, such as pre-primary level, first level basic education for 1st through 5th grades, and second level of basic education for junior high or middle schools, grades 6th through 8th. However, in 1997, the extension of compulsory education from 5th grade to 8th grade brought two different schools under one school system called primary schools. With these changes, the following administrative school systems were abolished: middle schools, junior high schools, junior religious high schools, and Anatolian junior high schools which teach science and math courses in a foreign language, such as English, German, or French.

Possibly because of the complexity of the primary school system, the curriculum changing efforts are even less apparent than in secondary science education. For more than 20 years, the same science curricula and textbooks with minor changes were published by the Ministry of National Education for use in the nation’s schools. However, in 1992, in order to be ready for the last legislative changing, primary schools science curriculum was prepared as one part, and in 1992, was published in the official newspaper of Ministry of National Education. Until 4th grade, the first three years of science are taught as a combination of social and environmental sciences four periods every week, and is called life science. The curriculum changes of 1992 did not cover the first three grades because of this dual emphasis (MEB, 1992).

Stated in the introduction of this new curricula were the reasons for these changes that “it is required to bring science curricula under one curriculum because of the extension of compulsory education from five years to eight years, the elimination of usage and uncomtemporary knowledge behind the century, the introducing of new concepts and methods, the scope and sequence of curriculum without repeating the same objectives” (MEB, 1992). This science curriculum mainly covers the universe and the earth, energy and substance, living organisms, and our natural resources. Some of the earth science concepts of this new curriculum were moved to the primary science curriculum despite the social science emphasis.

The significance of this new primary science curriculum is that it was prepared under the supervision of science educators, curriculum specialists, primary school teachers, and university science faculties; and was built on the experience of previous elementary and middle school science curricula. Therefore, it is easy to see the contemporary science education notions in the curriculum. For example, the mentioning of the nature of science and the scientific method as a way of learning and teaching has been included in this new curriculum. As a result of this new primary science curriculum, the purpose of learning science has been expanded to not only prepare students for the next level of school, but to prepare scientifically literate citizens who are able to use scientific facts in their daily life and understand basic concepts by using simple locally suppliable materials (hands-on science). Moreover, in spite of social and religious controversy in teaching evolution in schools, this curriculum prepares students for the natural selection and evolution science objectives they will find in their 8th grade science classes.
The Developments and Changes in Science Teacher Education

Along with changes in science curricula, teacher education, particularly science teacher education, has also attempted to make changes. The Turkish education system has from the beginning faced major problems preparing quality teachers to serve and teach in the nation's schools. First of all, the demand for quality teachers outweighs the number available, especially since the westernized educational reform movement. Even though many Turkish governments have attempted to improve teacher preparation programs, many times they simply create temporary solutions, such as allowing high school graduates or college graduates to become teachers without training. These stop gap solutions have been brought about due to higher demands and rapid population growth. This approach first occurred in the early 1940's by opening elementary school teacher training in senior high schools. These were boarding schools whose students were selected by exams and came mainly from villages, rural areas, and poor families. For this reason these schools were called Village Institutes—"Köy Enstitüsüleri"). Their graduates were teaching science courses as well as other courses in elementary schools. Middle and high school subject teachers of this period, including science teachers, were allowed to teach after three years of college. In addition to these education colleges, art and science college graduates who wanted to become teachers were also allowed to teach in high schools. In 1975, teacher training senior high schools were abolished and replaced with two-year junior elementary teacher training colleges. In 1978, all three-year education colleges were converted to four-year teacher training colleges. With these changes by the Ministry of National Education, teacher preparation was extended to the college level. Also during this time many elementary and middle school teachers, who had not graduated from these colleges, joined in service teacher training programs in order to complete and reach other teachers graduate levels. In 1982, with the university reform, all junior education colleges and other education colleges were put under the university system. And, in 1992, the number of training years was increased from a two-year to a four-year for elementary school teachers. This significant change ended the difference between the elementary school and high school teacher training period.

In spite of some significant changes in the development of science teacher preparation as well as in other subjects, many teachers still lack necessary subject knowledge and specific subject area teaching methodologies. According to National Educational Basic Law, in order to be a teacher, every teacher candidate has to have: 1) a field of specialization, 65% of total course work; 2) general cultural knowledge, 11% of total course work; and 3) a professional area concentration; this includes courses in teaching methods, measurement and evaluation, educational administration, psychology, and sociology. In addition to teachers' college graduates, college of science and art graduates who take the professional area courses as an extra option can be science or other field area teachers (Cahill, 1984; and MEB, 1995). Lastly, due to a shortage of science educators in teachers' colleges, method courses are general in nature, covering all fields but not specific to elementary and/or secondary science teaching. Therefore, since 1993, many master and doctorate students have been sent to the USA and UK through the National Educational Development Project (NEDP) supported by the World Bank (Thomas & Kaptan, 1997).

The next reform in Turkish teacher training calls for all teachers' college graduates to have a masters degree. With the change of compulsory education from five years to eight years, Turkey faces a tremendous elementary school teacher shortage. Again, the short-term solution has been to allow some college graduates whose major is not teaching to be appointed as elementary teachers (MEB, 1995).

Conclusion

Our history of educational reform is not unlike many of our neighboring countries. Change at a national level is a long-term process. We must not lose sight of the progress made while continuing to work for additional improvements.

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SCIENCE EDUCATION IN BRUNEI DARUSSALAM: EFForts TO COMMUNICATE SCIENCE TO STUDENTS

Dr. Hassan Hamid Tairab
Universiti Brunei Darussalam

Introduction

At a time when most countries started to take serious look to the status of science education in their curricular, educators in Brunei Darussalam are no exception. Since the introduction of science education eighty years ago, various efforts have been put forward to place science education firmly in schools. Nowadays, science is taught at almost all levels of education with increasing demands on teachers to make various initiatives to promote students' interest in and attitudes to science. Such initiatives coupled with the government derive to continuously update and implement plans to derive awareness of the contribution of science and technology to the development of the country, is believed to be of paramount importance to future interest of the country in order to meet its needs. Realising the importance of role of science and technology for future generation, currently the government is implementing a programme called Brunei Era of Science and Technology by the year 2001 (BEST 2001). It is a comprehensive and coordinated derive designed to help its people take an interest in science and technology and enhance student appreciation of the role of science and technology in the development of the country. It is being spearheaded by the Ministries of Development through its seventh national plan. The plan outlines the significant role of various sectors including education to prepare the nation to the challenges of the future.

In this article, the role of Brunei Association for Science Education (BASE) in deriving various efforts to promote science and technology is highlighted hoping to share such efforts and initiatives with other regional and national organisations in order to strive for more excellence and cooperation among individuals and educational organisation. It is also hoped that ideas similar to those generated by Brunei science students will be generated in other counties. In Brunei, it is believed that education and the pursuit of excellence is something that Brunei Darussalam is very much aware of (Ministry of Education, 1992) and consequently many efforts have been carried out by the educators to sustain national interest.

Education System in Brunei Darussalam

Education system in Brunei Darussalam comprises government schools and colleges and non-government schools. All children enter school system at the age of five, stay at the pre-school level for one year before proceeding to the first year of primary education. They spend six years of schooling at primary level. The primary level consists of lower primary (Year One to Year Three) and upper primary (Year Four to Year Six). All children will sit for a public examination before they proceed to the secondary education. The secondary education lasts seven years with the first three years as lower secondary, two years as upper secondary, and another two years as higher secondary which is commonly known as Advanced level. Students will sit for public examinations at the end of each level. After completing their secondary education, students with relevant credentials (i.e., Advanced Level passes) can proceed to higher education at local higher institutions or abroad.

Science is taught formally at Year Four including health science but students may be exposed to non-formal science at an earlier stages. At all levels and to ensure high quality education, the Ministry of Education lays down curriculum guidelines for pre-school, primary and secondary education guided by its national education policy.
Science curricular are continuously reviewed and revised to ensure quality with special emphasis on science being taught as activity-oriented particularly at primary level. Resources and facilities for modern science teaching are given priority by educators and therefore most schools are well equipped. Such as environment has provided teachers in general and science teaches in particular with challenges to strive for better teaching and learning. Hence, as part of these derives Brunei Association for Science Education (BASE) was formed twenty years ago to contribute to the promotion of science and technology education in the country.

**Brunei Association for Science Education**

BASE, Brunei Association for Science Education (BASE) is an umbrella for science educators formed in 1978 purposefully for promotion of science education in the country. Specifically the association aims to contribute towards the improvement of the teaching of science and technology in all levels of education to all children. As a professional organisation it also aims to promote exchange and sharing of ideas among its members through meetings and discussion of issues related to science and technology. In this regard, BASE has exerted numerous efforts to establish links with other professional organisations. Since its formation twenty years ago, BASE has developed close links with international organisations such as International Council of Association for Science Education (ICASE) and the Association of Science Education in the United Kingdom (ASE). Regionally, BASE has also established close relationships with its counterparts in Singapore and Australia.

Since its inception in 1978, BASE organises various activities for the purpose of promoting science and technology in Brunei Darussalam. Perhaps the most significant contributions are those which incorporate student activities. Two of the most important activities are the Science and Technology Week and the National Science Camp which are both student-based activities whereby hands-on-experiences are shared by students through individual and groups involvement in carrying out scientific projects.

**BASE Science and Technology Week**

Science and Technology Week is an annual event which incorporates all student-based innovative activities. It aims to stimulate student imagination and increase creativity and scientific participation among students. So far BASE has organised 19 weeks since 1978. Each year all student activities will be based on a theme to reflect the emphasis given to the role of the chosen theme. For example, the theme for 1996 week was 'Information Technology in Science Education' which included activities designed to bring about awareness in students as to the role of science and technology in the development of the nation. The 1997 week which marks 20 years of existence of BASE, carries the theme of 'Science and Technology Education for the 21st Century.'

Prior to and during Science and Technology Week, students are involved in broadly three kinds of activities, namely scientific quizzes, essay writing and exhibitions displaying individual or group projects designed by students. Scientific quizzes start earlier during the academic year as part of the extracurricular activities during which students compete at regional levels before being selected to represent their school nationally. The aims of this activity are to enhance student general scientific knowledge and promote scientific attitudes.

**Science Essay Writing**

Science essay writing is designed to promote creative writing related to science and technology and to uncover communication skills among school children and to inspire greater love for books and the desire for reading in students. In so doing it is hoped that it will propagate in children the idea that science is an intrinsic part of their culture and environment. Essay writing activity is designed for students in lower secondary (14-16 years old) and up to tertiary level. Students’ work will be judged by teachers appointed by BASE management committee and those which judged to be of outstanding nature will receive prizes and will be certified.

**Young Scientist Badge Award**

This activity is designed for students at primary level to supplement the activity-oriented learning approach being implementing by the science teachers in primary schools. Children may carry out an activity or any project of scientific interest under minimal supervision of their teachers. It is hoped that this activity which involves personal interaction and construction of knowledge by children will encourage and develop children positive attitudes towards the study of science at an early age and thus, promote more active approach to science. The activity is guided by science teachers as facilitators using a pre-planned strategies printed in a card which is similar to a log book where the student has to follow certain instruction to be able to complete the activity. An example of an activity card is shown in
Table 1. It is similar in nature to the ‘Stepping into Science Project’ run by ICASE since 1988 and the young scientist scheme operated in Singapore. Points are awarded on satisfactory completion of each activity. When sufficient points have been acquired, the pupil qualifies for the badge which highlights the participant achievement.

Table 1
Activity Card for Young Botanist Badge Award (BASE, 1996)

1. Make a simple plant press.
2. Make a collection of pressed leaves of ten different identified trees.
3. Produce the silhouette (shadow) of a tree.
4. Take a series of photographs of different trees to show the similarities and differences of particular part of the tree. Drawing may be accepted.
5. Design a flower-bed for your school and name the plants you intend to use.
6. Put up a display of dried plants in your classroom.
7. Raise 5 plants from cuttings (vegetative propagation).
8. Use leaves and paint/crayon/felt pens to make an attractive picture.
9. Make a collection of 5 different ferns.
10. Draw 5 different kinds of pollen grains. You may use microscope or lightscope.
11. Observe and make drawing of three different aquatic plants.
12. Draw and identify the flowers of 20 different types of flowering plants grown locally.
13. Make a bottle garden.
14. Keep at least 2 different types of plants growing indoors using improvised containers. Bring healthy specimens to show your classmates.
15. Photograph the growth of a flower from bud to seed/fruit.
16. Make a collection of 20 different types of plant seeds and display them attractively in a box.
17. Make a map to show the sites of the different trees in your housing estate. Name the trees.
18. Write a poem or imaginary story on flowers/trees/plants.
19. Put up a bulletin board on some aspects of plants (e.g., a display showing different methods of seed dispersal, useful plants, poisonous plants, . . . etc.)

Tasks associated with the activity card can be interpreted as follows:

- When the activity asks for a drawing or photographs, the pupil has to make a series of drawings or photographs sequentially to show the scientific principle(s).

- When an activity involves a visit or need further observation by visits, this can be done by arranging a class field trip to the site(s).

- Pupils are encouraged to present their work either in English or Malay language.

- When the activity needs experimentation, advice or consultation is available from teachers who normally act as facilitators.

Statistics for these activities were impressive. More and more children are given opportunities to practice their knowledge and skills and taking responsibility in their learning. For example, a total of 362 students from 14 primary schools participated in the young botanist badge award in 1996 and 131 students for the science essay writing competition. For science quiz statistics showed that 19 secondary schools were included in the quiz (BASE, 1997).

The National Science Camp

The national science camp is an annual activity organised by BASE during school holidays and run for 4 to 5 days. Students are selected from all government and non-government schools with some selected teachers. The aim of the camp is to provide students with opportunities to explore scientific phenomena and to involve in an interactive and inspiring environment that will encourage promotion of individual, personal and educational development. For 1996 camp, a total of 65 students selected from 31 schools participated in a 5-day activities (BASE, 1997).

For 1997 activities, a number of new initiatives designed to bring about more students' participation in science-related activities have been put forward. For example, 1997 science and technology week includes a scheme whereby secondary school students involve in carrying out small-scale research projects with the aim of developing investigative ability and skills of students. An example of such research project is given in Box 2. Pedagogical philosophy behind such project which are entirely student choice includes:

- Students will learn new ideas as they research aspects of the problem under investigation from texts, teachers and other adults at hand.
- School science to some extent has become more pure and conceptually demanding and has less
concerned with children experiences. Such projects will blend students’ experiences with school science and thereby making it more meaningful and understandable.

- Students will develop and increase their ability to communicate their ideas in a more scientific approaches.

- Develop positive attitudes to science and technology and be able, for example, to appreciate that learning by doing science can be fun.

- When students initiate their activities, and take responsibility for carrying the projects by making decisions and solving problems, they develop a sense of ownership which is a central feature of effective learning (Watts, 1991).

Table 2
Samples of Students’ Research Projects for 1997 Science and Technology Week

<table>
<thead>
<tr>
<th>Name of Project</th>
<th>Student Level</th>
<th>No. of Student Involved</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reuse, Reduce and Recycle</td>
<td>Lower secondary</td>
<td>3</td>
</tr>
<tr>
<td>The effect of different colours on plant growth</td>
<td>Lower secondary</td>
<td>3</td>
</tr>
<tr>
<td>Era of modernisation in 21st century</td>
<td>Lower secondary</td>
<td>2</td>
</tr>
<tr>
<td>Seed germination</td>
<td>Lower secondary</td>
<td>3</td>
</tr>
<tr>
<td>Diseases that affect the heart</td>
<td>Upper secondary</td>
<td>3</td>
</tr>
<tr>
<td>Hamster at work</td>
<td>Upper secondary</td>
<td>3</td>
</tr>
<tr>
<td>Oil, detergents and life</td>
<td>Upper secondary</td>
<td>3</td>
</tr>
<tr>
<td>Keeping fruit fresh</td>
<td>Upper secondary</td>
<td>1</td>
</tr>
<tr>
<td>Sources of rubbish in Brunei capital</td>
<td>Upper secondary</td>
<td>2</td>
</tr>
</tbody>
</table>

The derive behind all these activities, of course besides fulfilling its professional role as educational organisation, BASE has come to a realisation that for Brunei students to be prepared to function in their future, they need to be equipped with the knowledge and skills which enable them to fulfill their role in an increasingly technology-oriented world. It is becoming evident that perception of science education has to move from its traditional look to a more progressive ways that consider evidence of learning. Kuch (1997) emphasises that students must be partners in their education by taking active rather than passive role. In so doing they will be able to show evidence of learning by being able to discuss and share scientific and technological issues related to themselves and their environment. The kind of projects that BASE has been carrying out since its inception has brought about significant changes in student perception of science. We often hear students commented on how science is boring and hard to understand. Though so far no systematic studies have been carried out to assess student attitudes to and perception of science in relation to BASE activities, students often remark that their participation not only giving them opportunity to learn science in a naturalistic environment but also help them to develop friendships, cooperation and independence.

References

Science Teacher Education and Leadership

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This section focuses on the education of science teachers, and aims to communicate ideas and strategies which will assist science teacher educators to enhance and enrich their programs.

SPACESHIP NIGERIA: A TOPIC STUDY FOR GLOBAL WARMING, GREENHOUSE EFFECT AND OZONE LAYER DEPLETION

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Why Topic Study?

Topic Study was created at Jordanhill in Glasgow to meet the needs of teachers seeking to integrate their teaching, rather than sticking within subject boundaries. It has transferred successfully to many education systems, in many countries. We believe it offers a remarkably fresh and effective way for delivering Environmental Education.

At heart, a Topic Study asks the teacher and learners to join together in imagining a context, somewhere where something can happen. Together they describe it, draw it, and write about it, explaining it as best as they can. They learn about the "models" of the world they and others have in their heads. Sharing ideas, questioning each other’s ideas, leads to the ideas being changed and improved. The topic is not static. A story is told. So changes occur. The teacher can make things happen. The children must then work out what best to do. A Topic Study is exciting and fun. Children say “It's better than work,” but will spend endless time and effort on it. They feel a sense of “ownership.” It is their Topic, the teacher is seen by them as the one who “only makes suggestions.”

Two Theories of Education

One model of education sees it as teaching, where the teacher does the thinking and the work and the pupil simply memorises. The child’s head is thought of as an empty bucket waiting to be filled. The teacher carefully prepares the knowledge into parcels and throws these at the child. Sometimes a parcel would miss, sometimes it would be caught by the bucket. Even if the parcel was in the bucket it could fall out when the child was playing or messing about. Some children’s buckets are full of holes and the parcels just fall through.

At the end of the teaching, the teacher sets a test. For every parcel of knowledge the pupil can find in his or her head they get a tick. For each one they have lost, they get a big red cross.

Active Learning

The other model of education considers that children’s heads are not empty. There is a brain inside. The brain helps the child interpret the world by creating models of what the world is like. The role of the teacher becomes one of changing and improving the models children already have in their heads. Much as we, the teacher, sometimes feel the desire to do so, we are not able to get inside the child’s brain. We can’t poke in our fingers and sort out their ideas. We have to get the ideas out. We must help them share their models with us.

There are four ways of bringing out the models:

Talk—they tell us about their ideas
Show—they show us things, with actions
Write—they put their ideas in words on paper
Draw—they use all the kinds of drawing skills.
Text 1 A Dying Planet

The Earth was dying. The forests were gone, the sea polluted, and fish driven to extinction. Now the crops were failing because of soil loss, changing weather patterns, and new and unexpected disease. Global warming was unstoppable. Millions if not billions faced a slow death by malnutrition, starvation, or genocide, as social order broke down. Those with power and money looked for an escape. Could they use their wealth to survive? One solution was to seek new lands but there were none left . . . on Earth. They paid scientists to search the skies for a new planet. One where they could, given time, recreate Earth. The search was successful. There was a suitable planet. The problem was that it was so far distant that it would take 250 years to reach. Or, as scientists could be very exact about these things, 248 years, 34 days, and 6 hours! The problem was to design and build space ships which could make the voyage. Teams of scientists were selected to advise and help.

Text 2 Space Convoy

The huge space ships were designed as modules which could be joined in space held together by passageways like the spokes and rim of a great wheel. Each module was similar but adapted for its particular function. Space ship Nigeria had modules for Energy and power, Recycling and recovery, a species bank, accommodation, education, health, passengers in hibernation, workshops, entertainment, and a command centre. At the centre of the wheel was the life support system. Plumbing and other services were visible on the outside of the modules. So each module was easily recognised. Inside, the walls and rooms were arranged to suit the function of the module. Each module was allocated to a separate design team, so that all would be ready by the launch date. If the deadline was missed by one module, the whole spaceship would never leave earth orbit.

Text 3 The Crew and Passengers

Many more people wanted to go than there were places for. Committees were set up to determine the criteria for selection. There were two categories; crew and passengers. The crew would be there because their skills were essential for the success of the voyage. They would also need to be replaced when they became old and useless.

The passengers included the rich and powerful. They decided that they needed others to make life on the new planet a success. Some passengers would come abroad “alive” some in deep sleep at low temperatures, and some frozen in the deep freeze in the hope that they could be revived. The organisers asked groups to draft proposals for the selection criteria. A consensus would be established.

Text 4 Life’s Necessities

Life on board the ship would not be much fun. Luxuries would not be allowed; only the necessities of life. Although this rule was established early in the planning, it became clear that different teams and people had different ideas. A plan had to be found to develop a list which all could agree to. They asked for suggestions, seeking one page summaries from each team. If no better suggestion came up, then each would create its list then present it to the others, who would accept or reject items. The finished combined list would still need to be shortened.

Text 5 Sourcing Necessities

Even simple “everyday” items are the result of many activities, indeed a chain or “tree” of processes. The organisers knew that the spaceship would be too far away for help, so they had to make sure they forgot nothing that could endanger the voyage. They approached consultants and found that “backtracking.” Each item selected as an “essential” was considered. Its parts were identified, and sourced. But where in turn did these parts come from? How had they been made? Where had the factory, the raw materials, and the energy come from?

Experts said that everything could be traced back to minerals and elements and energy sources, usually the sun. As an example to explain the process, they selected the ball point pen. It was made of three kinds of plastic, a brass writing head, a tungsten ball, and filled with ink. How had these parts been made, with what techniques, what resources and what energy. They put their heads together and thought.
Text 6 Energy Sources

The importance of the Sun was a matter of concern. It would only be a few months before the ships were too far from the Sun to be able to harvest its energy. A portable source of energy was needed. All fuels were considered. Whatever fuel system was to be used, they would have to take care not to be wasteful. Scientists told them that energy did not disappear, it was never destroyed; just converted into other forms and spread out. “Using energy” was a process which took stores of energy and scattered them. The organisers asked if the scientists could think of ways to recover the energy for use, like they could recover the metals and plastics and other materials. It was difficult for the scientists to explain this. Why can’t the scientists recycle energy?

Text 7 Sustainable Life Support System

Once the energy source had been decided upon, the teams of scientists were asked to submit designs for the core of the spaceship—the sustainable life support system. The message from the ecologists was this. Simple systems can easily swing out of balance and need very close monitoring and control, yet complex systems seemed to be able to create stability from their very complexity.

The choice, therefore, was to create a computer monitored and controlled simple system, with all the risks, or to establish a complex ecosystem transplanted from earth. Was there any other way?

Text 8 Space Pirates

There had always been rumours that there were other convoys in space. These had been poorly designed and their life support systems failed to meet the needs of all who boarded. Fighting had broken out, and so the rumour went, a ruthless group had seized control. They had stopped trying to make their spaceship work, and instead had adapted them for attack. They prowled through space, seeking defenceless spaceships to plunder, so that they could survive themselves. Unknown to everyone was a new danger. After the convoy had left, the rich who had been rejected, the drug lords, and other criminals of the world, had designed attack ships. These were on their way.

Text 9 Memories of Earth

In the school, the children who had been studying Earth history were asked to write an imaginary poem describing what living on Earth might have been like.

The structure they used was a sense poem. The teacher gave them headings:

- see
- smell
- touch
- fear
- hear
- feel
- do
- wish

When the class or groups had come up with good expressive phrases, the teacher rubbed out the first two words on each line. Now, they had a poem.

Text 10 Messages to Earth

After many years of journeying, the crew decided that they should send messages to Earth. They wanted to say that they had learned to live with limited resources, never wasting materials or energy, and making sure that they recycled everything. They thought it was right that those on Earth should be told. Now they realised that Earth was itself a spaceship traveling through empty space with no hope of help from outside. The “crew” of Earth had to make their spaceship work.

Text 11 A Message from Space

Earth had not done well in the years since the spaceships left. The message was too late. There was no-one who could do anything, for it was a question on individual survival. There was no hope, no-one to tell, all was lost. The stinking hulk of the once beautiful Earth would forever drift in space. It need not have been so. The message from space could have been learned in time. What are the implications globally, nationally, locally and individually of the message from space? Select a part of another group’s message and write a response to it under the four headings.

GROUP REPORTS

Editor’s Note:

As a sample of just how powerful a teaching tool this approach can be, the authors have included an outline of topics and ideas generated by groups as they actively engaged each of the previous Topic Study scenarios. These thoughtful reflections could serve as guidelines for your own groups. But please remember that the authors are NOT suggesting that these or any specific responses are "correct." It may be useful to either ignore these "other group" conclusions or use them as simply a helpful suggestion list that you draw upon for groups who are having difficulty generating their own ideas.
Text 1: A Dying Planet

Design of Spaceship
- Suitable raw materials
- Eco-balance
- Suitable source of energy
- Recycling facilities
- Modulation of temperature
- Alternatives to non-environment friendly materials

Text 2: Space Convoy

A list and specifications of the requirements for each module should be prepared.

Text 3: The Crew & Passengers

Crew
- qualified and skilled
- sound health
- relatively young
- able to train and pass on the knowledge and skills

Passengers
- Good health
- Ability to endure low temperature
- Rich and influential
- Scientists
- Industrialist
- Sportsmen and women

Text 4: Life's Necessities
- Water
- Suitable Power Supply
- Ventilation
- Drugs
- Friendly Eco-Environment
- Exercise and games facilities
- Transportation
- Balance Diet
- Adequate Accommodation
- Textile production
- Security
- Entertainment
- Education

Text 5: Sourcing Necessities
- Water—Water cycling materials required
- Suitable Power Supply—Suitable source of energy; Oxyacyetylene for welding
- Drugs—Petrochemicals and Medicinal plants
- Textile Production—Cottage Industries
- Education—Books made from the vegetation
- Friendly Eco-Environment—Suitable Environment; Vegetation
- Generally: Source of the Necessities in Text 4 are the target of this text

Text 6: Energy Source
- Solar: Solar Batteries = Electrical energy = Re-energise the solar battery
- Fuel: Coal, Crude oil, etc.
- Steam Engine: Water (Cycling plant) Steam energy (power the Engine)—Water—Steam
- Nuclear Energy: Nuclear batteries from radioactive materials
- Solar: Potential energy (plant through photosynthesis) -> Chemical energy (Organism) -> Heat -> Plant (chemosynthesis)

Text 7: Sustainable Life Support System

Complex Ecosystem
- Transplanting of plants
- Water Cycling
- Suitable Conditions
- Balanced Ecosystem
- Suitable Energy Source
- Adequate Water Supply
- Good Cooling System

Computer Monitored & Controlled
- Human resource to compliment computers
- Trained personnel to monitor & control system inside spaceship
- Trained personnel to control materials, e.g., security
- Control room—Computerised

Note: High level of risk involved here.
Text 8: Space Pirates

- Appropriate Defence System
- Will Power
- Manpower
- Anti-missile gadget
- Facilities modified to perform many functions
- Modified Radar System
- External magnetic field to shield the spaceship
- Formation and training of an army
- Computerised Signals Department

Text 9: Memories of Earth (by one group)

- The picture of an eco-balanced Earth.
- The sound of rivers flowing and cries of animal.
- The sweet aroma of beautiful flowers, green and lush vegetation.
- The radiant heat of the sun.
- The sample of the remains of the Earth.
- The things that are eco-friendly.
- The calamities caused by ozone layer depletion and global warming.
- For a new Earth that is eco-friendly.

Text 10

Dear Inhabitants of Spaceship Earth,

Messages to Earth

It gives great pleasure to write you our experience in our Spaceship. Over our long journey, we have learnt that it is possible to live with limited resources, never wasting materials or energy and making sure that every resource is recycled.

However, realising the state where we left the earth, we believe that more damage will have been done by now. However, the earth should not lose hope but rather should be thinking on how to remedy the situation and we hereby offer the following suggestions:

1. Environmental monitoring agency: You should now set up a lush powered and result-oriented agency that will monitor the utilisation of your natural resources. It should be well funded to enable it to perform.

2. Food: There should be no wastage of food. Excess food should be preserved. Every inhabitant needs to be well educated on how to do things.

3. Balanced Ecosystem: The inhabitants on the earth should ensure that there is a balanced ecosystem.

To ensure that this is done, for every tree pulled down, there should be a replacement. And this applies to other resources like animals and fish, etc.

4. Water: Ensure that you recycle your water. This was already being practised in developed countries before we left. The idea should be sold to the developing countries.

5. Health: To prevent sickness and diseases ensure that your inhabitants take balanced diet. However, in order to take care of the sick ones, ensure that you have well trained medical personnel (doctors & nurses, etc.)

6. Education: Studies on Environmental Education should form an integral part of your education at all levels so that every individual will learn to take good care of his or her environment.

7. CFCs: As a matter of urgency you should find alternatives to the synthetic materials which lead to increase of CO2 production and depletion of ozone layer.

8. Earth population: The inhabitants on the earth should monitor population growth and if possible limit the number of children per family.

We wish you speedy recovery.

Yours Sincerely,

(Signatures by group members)

Text 11

Global Implication: Over population, food shortage, CFC accumulation, disease, UV emissions, Desert encroachment, high temperature, high CO2 build-up.

National Implication: Overpopulation, high mortality rate, disease, inadequate housing, ecological problem, food shortage.

Local Implications: Means of livelihood threatened by deforestation. Overcrowding, poor ventilation, under employment, increase in crime rate, poor health conditions.

Individual Implications: Skill problems, psychological problems, bush burning, malnutrition, health hazards, social problem.
Non-formal and Informal Science Education

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This section focuses on the interface between non-formal, informal, and more traditional formal science education. Articles expose the world of out-of-school and public science experiences.

Defining How and Why the History of Science Might be Included in Informal Science Learning Opportunities

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An appreciation of the entire span of history cannot be arrived at by an audience simply by reciting a sequence of historical events. A sequence begs the question: whose history? whose culture? whose language? whose discoveries? Since science and technology play such a large role in our current society, the history of science (HOS) and technology is of particular interest. At the same time, institutions with an interest in education are under increased pressure to represent a variety of cultures, ethnicities, points-of-view, etc. How then can the individuals responsible for the organization of education operationalize larger, more inclusive agendas without being divisive or seeing only narrow slices of history?

A question we might ask is why bother to include the HOS into science museum exhibits and other informal learning experiences? A simple answer might be modeled along the lines of the posters that show a drawing of the Milky Way galaxy, with a small arrow pointing to a rather small star, labeled, You Are Here. Audiences exposed to and shown their position with respect to the HOS have an opportunity to create a context for their own current relationship with science. Understanding how science evolved and its future directions may help people construct meaning from their own journeys with science.

The intent of this paper is to serve as a starting point for discussions that intend to define the mechanisms and rationales (the how and why) for the inclusion of the HOS in the construction of informal and nonformal science learning opportunities. These opportunities might range from a bulletin board or learning center in a classroom to a museum exhibit or television show, but the intent remains the same—an opening for dialogue to emerge between the producers and the consumers of such a learning opportunity.

Approaches to the History of Science

In considering how the HOS might be presented in an exhibit, several approaches are available that might reach out to and 'grab' a particular segment of the audience. Briefly, they are:

- Milestones and Artifacts
- Historical Figures as Exemplars
- Cultural
- Interpretive Entity
- Linear Sequencing

Each of these approaches is outlined below, along with a brief comment on the advantages (or occasionally, disadvantages), opportunities, and considerations offered by each approach. Caveats to the application of these approaches are presented in the final section of this paper.

Milestones & Artifacts

One approach to including the HOS in an exhibit is to examine history as a sequence of milestones or artifacts. An artifact is examined from the perspective of the motivation and thoughts that the artifact developer experienced. A human face is placed on technological innovation by concentrating on the developer of a process, an invention, or a procedure and how he or she worked within (or outside of) his or her culture. Milestones should highlight lesser known inventions and inventors, especially those of women and minorities. Doing so allows the display to go much beyond the commonly known exemplars, such as the assembly line (Ford), the light bulb (Edison), or vulcanized rubber (Goodyear). Patent applications can be used as "mini case studies" in examining the innovation from the perspective of the developer as the project progressed from its inception to the granted patent number.
A larger case study of an artifact might consist of a portfolio for an innovation. Such a portfolio would consist of: (a) the inventor and his or her social context, (b) the relationship of the innovation across contexts (e.g., the hearing of a voice with respect to the way a telephone works), and (c) relationships that forge links across unrelated or marginally related field, (e.g., Olympic competitions and precise electronic controls). Each component within the portfolio can serve as a "jumping-off point" to whatever other dimension an exhibit developer wishes to explore. Care must be taken, however, to avoid a fetishism of invention (Barber, 1952), such that the product is taken for the process, overlooking the context in which the actual work occurred. As James Burke stated somewhat facetiously in The Day the Universe Changed, "Isn't science wonderful? . . . Scientists make gadgets, don't they?" (Burke, 1985). Scientists may make gadgets, but might do so, for reasons or, by using methodologies that others might find unfamiliar.

**Historical (and not so historical) Figures as Exemplars**

The use of historical figures as exemplars in expressing the HOS is closely related to the use of milestones or artifacts. The difference lies in a focus on the developer, not the artifact produced. An attempt should be made to re-contextualize the visitor into the atmosphere that the figure worked within, including motivations and influences on the individual, including more entrepreneurial influences. The approach goes further, suggesting possible consequences of the work, both positive and negative. For instance, the individual scientists that developed high-yield rice plants for the third world did not consider the cumulative effects and costs of increased pesticide use (the indigenous insects found the plants very tasty). The result was that after years of encouraging local farmers to use the new plants, rice yields actually decreased, causing famine and disease.

One view that must be combated is the separation of the individual from his or her culture. The view of science in the early 20th century was that a pure science exists free of social factors (Barber, 1952). The list of scientists motives covers the whole range of human desires and aspirations (Lilley, 1948-49, p. 385). The notion at issue is not whether the mind guides action, but whether the mind determines the selection of the list of culturally acceptable thoughts and actions (Harris, 1979, p.60). Scientists are not appreciably different from others within a culture; they reflect the mores of their culture. For example, many 18th Century authorities found Linneas work objectionable, as he classified plants based on their reproductive parts, using anthropomorphic analogies (Schiebinger, 1996).

Another consideration is the level or stature at which the figure is presented (Brush, 1974). Is the figure to be presented as a high exemplar, well above the norm and thus at an unattainable level, or more a more humble, "just like me"? Each viewpoint has the potential for alienating a certain portion of the audience, either by scaring them away, or by diminishing the figure to the merely ordinary. A careful balance between them must therefore be maintained.

**Cultural**

History of science may be approached through the cultural dimension, which offers an ethnic or cultural perspective about a sequence of events or development of objects. This approach can take on one of two forms. The first of these is an ethnocentric approach, from which one ethnic group developed or used some technological innovation at the expense of another ethnic group, or systematically suppressed another culture’s innovations. While ethnocentric viewpoints might be seen as perhaps destructive in general, they do have the advantage of the “outsider’s” point of view, a viewpoint which many visitors might identify with.

A second aspect of the cultural approach is the suggestion that ancient cultures had developed knowledge and understandings of some basic scientific principles that equal or rival those of today, based largely on the interpretation of myth and metaphor in ancient texts. Such knowledge was subsequently lost or perhaps suppressed. This approach can be seen as largely conjectural, depending on an exhibit developers definitions of culture and interpretations of myth. Barber (1952) suggests that it is an error to assume that science and empirical rationality are modern, western developments. The biases of dominant societies, toward earlier or other societies, have overlooked the nature of the innovations because, perhaps, they were the development of other peoples or marginalized populations.

**Interpretive Entity**

Another way to incorporate the HOS in exhibits is to show it as an interpretive entity. What is done for exhibit development in this approach is to examine well known and understood phenomena, especially the HOS that are constant across time and are evocative, such as meteorologic events. The task is then to document the transition from a myth-based to a science-based description of that phenomenon. The myth-based views
assumes that there is some meaning, perhaps divine, within an event. The science-based view assumes that the event is an impersonal expression of physical laws. Such assumptions are not confined to the ancient or distant past, such as the myth-based explanations of the AIDS epidemic as divine punishment for particular lifestyles.

The distinction between the myth-based and the science-based interpretations lies in the desired outcome of inquiry: do we wish to understand the will of the gods or a comprehension of events causing the phenomenon? The answer to this question becomes the difference between “why?” and “how?” The difference is embedded in the social context of what audiences consider an acceptable line of questioning. What is to say that a myth-based line of inquiry is any less valid to the culture it is embedded in? As Goldstein and Goldstein (1978) emphasize in their example of the behaviors of witch doctors, “how?” is often an inappropriate question, not because it is wrong, but because it is seen as irrelevant. What passes for “normal science” (Kuhn, 1962) is deeply ingrained into the culture of the audience. If, then, the goal of an exhibit is to increase the appreciation of and motivation for scientific inquiry, the exhibit developer must consider both the “myths” and the “science” of the target audience of an exhibit. Only then can the exhibit act as a gateway to self-motivated inquiry.

Linear Sequencing

The HOS in an exhibit can also be developed as a more traditional linear sequence of history. Given a broad scientific concept, such as light or sound, the exhibit would trace the development of our understanding along or at specific time referents or periods, such as: (1) the Greek legacy, (2) the Middle Ages, (3) the Scientific Revolution, (4) the Enlightenment, (5) the 19th Century, and (6) the 20th Century. Specific innovations or discoveries within these time periods could be demonstrated. Individuals and their work can be highlighted in each period, emphasizing the research tradition of the time period with respect to the broad concept. For instance, improvements in instrument making in the 16th and 17th centuries allowed for more accurate and precise measurements of phenomena. These improvements in instrumentation arose from the needs of the scientific research itself (Barber, 1952). Thus the context of discovery becomes especially relevant in the exhibit design.

This approach has the disadvantage of being chronological and temporally dependent. It also has the distinct disadvantage of presenting only one culture’s developmental periods. The entire exhibit would have to be restructured for each culture’s history. To overlay cultural periods on a single time would have the potential to overload the visitor, who would then “vote with his [or her] feet” (Fayard, 1991) and walk away from an exhibit so crammed with information.

Caveats

All too often, it is easy to overlook some of the darker or less palatable aspects of history for fear of alienating an audience. A constructive postmodern approach to the HOS calls for the inclusion of as many of the aspects that surround a particular event or innovation as is possible. These aspects include both positive and negative effects. One of the legacies of the modern age with respect to science has been an air of optimism regarding technological advance (Barber, 1952). From the development of antibiotics to putting a person on the Moon, the general public has been of the opinion that science and technology can solve or surmount any problem, from the life-threatening to the purely mundane. Exhibits in museums have tended to reinforce and promote this point of view. In a practical sense, however, if a goal of science education is to promote scientific literacy for all (AAAS, 1989; NRC, 1996), then it is important for an exhibit developer to include as much information as possible for the audience to make informed decisions on scientific issues. Outlined below are three approaches to representing the rest of the story.

Scientists’ Behavior and Science Education

An important caveat in the presentation of the HOS is the contention that how scientists actually behave may not establish a good model for students to follow (Brush, 1974). If the intention of including the HOS in an exhibit is to educate the public in how scientists work and thus provide a methodological framework, we do science a great injustice by diminishing its true nature to one standardized approach. Science and history have the potential to ‘do violence’ to each other by the inclusion or exclusion of particular temporal and social contexts (Brush, 1974). As a result, science education produces ‘anecdotes’ that are only marginally “history”.

Whiggism

From an educational viewpoint, any exhibit including the HOS must contain information on cultures within the dominant culture (SciTrek, 1993). The rationale for this inclusion is to prevent the promotion of a whig version of the HOS (Brush, 1974). A whig
presentation of the HOS has the exhibit developer judging the accomplishment of scientists of the past by today's standards, removing the context that such scientists worked within. For example, it is tempting and quite easy to brand pre-Copernican astronomers as being ignorant of how astronomical motion took place, when in fact these same astronomers used the best available information, as they understood it, to arrive at their models. The whig view presents scientific forbears as persons to be pitied or looked down upon because they just weren't as good as us. Bowler (1989) goes on to describe whig history as, an invented past, since factual discoveries [are] interpreted within the conceptual scheme that satisfied cultural demands of the age (pg. 3). Progress can be slowed by villains but never halted, as purposeful development is inevitable (Harris, 1979).

Technological Revenge Effects

With the dawn of the postmodern age, the darker side of the advance of science has been exposed. With Rachel Carson's *Silent Spring* (1962), the down side of technology, through the use of pesticides, was made all too apparent. Recently, a bleaker picture of our future has been portrayed by Laurie Garrett in *The Coming Plague* (1994). Humanity's expansion into new environments, the increased mobility of humans, and the widespread use (and misuse) of antibiotics and medical equipment has promoted the emergence and diffusion of new and deadlier diseases. Extreme elements of the lay population seem all too willing to assign responsibility for such problems to scientists.

Tenner (1996) has summarized these down-sides as revenge effects, such that the application of science and technology to problems has unintended consequences. According to the revenge viewpoint, technological advances have had the effect of: (1) increasing unpredictability in life, and (2) demanding more, not less, vigilance on the part of the users of the advances. For example, widespread prophylactic use of antibiotics has had the effect of selecting for superbugs, or multiple drug resistant (MDR) microbes (Garrett, 1994). The overall reduction in acute health care problems, many of them previously fatal, has increased the cost of health care by allowing people to live to an age where chronic health problems, such as cancer and heart disease, are much more common (Tenner, 1996). The revenge effect need not, however, remain a constant. The modern approach to problems was one of brute-force. Overcoming or preventing revenge effects in a postmodern world requires greater finesse, attacking problems from the side (Fayard, 1991) or turning potential problems to our advantage. In short, to carry on and survive, we must substitute brains for stuff (Tenner, 1996, p.275). For the dark side of science and technology to be constructive and informative, therefore, it must be represented in exhibits by solutions and their quest, not in terms of problems and their effects.

Conclusions

Science, regardless of the culture in which it progresses, is a cultural and historical universal, in the absence of a more acceptable means of knowing (science for all). To urge, however, that the viewpoint of scientific observers is one among an infinity of equally valid viewpoints surrenders our intellects to total relativism (Harris, 1979, p.45). Cultural relativism (science of all) does harm by offering an ideology which promotes fanatics that seek to tear down destroy rather than build up.

Including the HOS in a display requires a representation of the needs and expectations of the audience. Each approach to the inclusion of the HOS outlined above has the potential to reach a segment of the potential audience, but each segment must come to expect that its needs would be met. As compared with the scope of history and science within a formal educational setting, informal and nonformal approaches have the potential to reach a much broader audience and retain that interest. So if we wish for individuals to know where *You Are Here* is in history, they should do so in awe of and not in fear of the totality of history.

References


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**SCICON 98**

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DORM LIVING IN THE ELEMENTAL AGE

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Editor's Comment:
As you read this wonderfully creative approach to the introduction of the Periodic Table, please feel free to change specific items to make the activity fit your student's culture. Also remember that ICASE copyright policy allows our members to reprint this and other articles in local journals.—Ronald J. Bonnstetter, Editor

You're a young element out on your own and need a place to live. You've heard that Mendeleev Tower on Periodic Plaza is a really great place to be—plush accommodations, hot and cold running electrons, sauna, workout area, the whole nine yards—but there's one catch. The management is very selective about the elements they rent to; some would say they're extremely picky. "We here at Mendeleev Towers are very concerned about relationships among our renters. You have to be in sync with your neighbors, you know, no personality clashes, no squabbles, just perfect harmony. Here is your renter's application. Before you are selected, we must have a complete personality profile before we can place you in just the right room. Yes, we select it for you because we know just the kind of elements that fits in. Oh do include your family pedigree; we have to know what kind of element you are. We cater to a very select clientele, you understand." The manager hands you a lengthy list of questions with a family personality profile request that would choke a moose. You roll your eyes at the prospect [the manager rolls them right back].

This task is overwhelming! So you gather a few of your closest associates and prepare to tackle the monumental catalogue of questions. You consider dividing them up between you in order to meet the manager's deadline (hint, hint).

(The following refers to the application form on page 33.)

Name: (well, that seems simple enough, but this "Meaning or Origin of Name" is really odd)

Chemical Symbol: (identifying mark for your doorbell; must be short, one or two letters)

Electron Configuration:

Valence Electrons: (isn't that getting rather personal?)

Temperament: (the manger's cryptic explanation was something about how hot you can get before you get boiling mad) and the second explanation was concerned with you when you are just a puddle of emotions—something about melting:

Rationality:—"How dense do they think I am? Of course I'm a rational element!!"

Country music preference: (what? you say—"well, the last place I lived, the guy upstairs always doing this hideous stuff he called music, but I swear it sounded like a cat fight") [At this point, your friend accused you of being extremely electronegative, only liking polka and accordion music. Those with + electronegativity are true connoisseurs of country, whereas those who have a negative value can't tell if the singer was Garth Brooks or Mel Brooks (and they don't care either!!!!)]

Now for the really personal stuff.

Waist size: (you scoff: "Is that before or after lunch??") Your other friend pointed out that they need to know your radius, both covalent and ionic, to make sure you fit through the custom-designed doors)

Mass: ("We have found that by arranging our clientele by increasing atomic mass has resulted in the most structurally sound environment")

Occupation: (what is it that you do to be a useful member of elemental society? What can you make of yourself?)
Hobbies:  (what do you do during those creative moments when you aren’t at work; be inventive!)

Date of discovery:  (well, I’m still waiting for my star on the sidewalk, but … I first showed my face on … )

Where discovered/Place of origin:  (not under a cabbage leaf! not at Graumann’s either!)

Discovered by:  (Oh, yeah! the doctor that assisted at your delivery.)

Family habits (Personality traits/chemical properties):

What kind of question is that? Who wants to know about Auntie Cesium, anyway? Just because she doesn’t do well with water … oh, I suppose that’s to determine who gets to use the hot tub … but I don’t have any idea why they have to know about grumpy old great uncle Boron—his stories put you to sleep. And then there’s those snobby Noble gases … Ow! [Your friend slapped you siller.] “They want to know if your family has any embarrassing habits like trading electrons with just anyone or if someone has been a real tightwad, keeping all their electrons for themselves and not sharing. That sort of thing.”] Oh. How am I going to find that out? Interview all my relatives? [you ask yourself, wishing you’d written down the life stories of all your relatives at the last holiday feast when Uncle Boron rattled on and on and on and on]

You suspect that this might be a involved section and would be very important to the manager. Since you don’t know your relatives very well, living so far away from them and all, that you split up the skeleton seeking among your associates, so they can help in the detective work. [another big hint]

Relations with neighbors:
(By this time you are wondering if this is more trouble then it’s worth. “Why can’t we all get along? Sharing electrons between elements is the only way to go,” you utter under your breath, but realize that not all elements share your feelings. “Yup. Some of them are just looking for a good fight and are only in it for the electrons they can grab.”)

Color Preference: (“Studies show that our elements prefer to live in rooms decorated to match their own true colors”)

**Neighborhood Preference:** After all your research, you have decided on the section of the Tower you’d most like to live. Where is it? Who are your intended neighbors?

You decide that you are going to need some kind of edge if you are going to get a spot in the Tower, so you send a couple of your associates to check out the neighbors. What kind of elements are these anyway? What kind of skeletons are in their closets? Do any of them have any unseemly family habits? And what about the guy upstairs?

***************

**Back to the Real World—translation and directions**

In your group, you will have the opportunity to investigate the family background of an element, and submit a completed application with answers to all the questions above. The “manager” will provide some background reference information on you and your “relatives.” Many of the questions can be answered with information in your textbook. Encyclopedias and other library material may also be found useful. Or if you choose, you could check out one or more of the **Various Periodic Tables on the Internet**:

http://library.advanced.org/3659/pertable/
http://www.shef.ac.uk/chemistry/web-elements/
http://www.shef.ac.uk/chemistry/chemdex/periodic-tables.html
http://smallfry.dmu.ac.uk/chem/periodic/elementi.html
http://wild-turkey.mit.edu/Chemicool/
Application for Rental Unit (condensed version)
Mendelev Towers

Feel free to use extra sheets of paper if necessary. Answer questions completely.

Name __________________________________________

Meaning or Origin of Name __________________________________________

Chemical Symbol __________________________________________

Electron Configuration __________________________________________

Valence Electrons __________________________________________

Temperament (boiling) __________________________________________

(melting) __________________________________________

Rationality __________________________________________

Country Music Preference __________________________________________

Waist Size (covalent) __________________________________________

(ionic) __________________________________________

Atomic Mass __________________________________________

Occupation __________________________________________

Hobbies __________________________________________

Date of Discovery __________________________________________

Where Discovered/Place of Origin __________________________________________

Discovered by __________________________________________

Family Habits (Personality Traits/Chemical Properties) __________________________________________

Relations with Neighbors __________________________________________

Color Preference __________________________________________

Neighborhood Preference __________________________________________

In a minimum of three paragraphs, describe why you desire to relocate in Mendelev Towers and where you think you would best fit. Please include a description of the outlook you would bring to our unit, as well as how your presence here will benefit all of the current clients. Feel free to add anything you find unique about yourself that would be interesting to us, especially any recent newsworthy items. We are especially proud of our clients with celebrity status!
Book Review

SCIENCE, MATHEMATICS AND TECHNOLOGY EDUCATION & NATIONAL DEVELOPMENT CONFERENCE
HANOI, VIETNAM. 1997

Darrell Fisher and Tony Rickards
Editors

This unique conference provided an intellectually challenging and culturally enriching experience for science and mathematics teachers, teacher educators, researchers and administrators at the primary, secondary and higher education levels from around the world. Over 100 participants from 14 different countries had an opportunity to interact and exchange innovative ideas, research findings and practical implications in the traditional fields of science, mathematics and technology as well as new areas of international significance related to the conference theme.

The book contains over 50 papers that were presented at the conference on recent research and practical implications in science, mathematics and technology education covering the following areas:

Research Methods  Curriculum
Teaching  Learning Environments
Equity  Assessment and Evaluation
Teacher Education  Education Technology
Learning  History & Philosophy of Science

The book would be useful for mathematics, science and technology researchers, teachers and postgraduate students.

For details on how to order copies of the book please contact:

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Western Australia

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Opportunity for USA-China Links Program

With the rapid changes in China’s economy, Chinese educators face extraordinary challenges as they work to educate 1.4 billion people. The Beijing Institute of Education has asked us to connect more than 100 elementary and secondary schools with schools in the U.S. through our U.S.A.-China Links program. We are seeking schools to become partners with Chinese schools.

We encourage you to share this information with colleagues and students in your area and throughout your network. For more information visit our website at http://www.goodnet.com/~global or contact us directly by phone at 602/943-3922, FAX: 602/943-4458 or e-mail: global@goodnet.com.

Thank you

Jerrie Ueberle
President, Global Interactions
TEACHING ETHICAL ASPECTS OF SCIENCE

Patrick Fullick and Mary Ratcliffe
Editors

Increasingly, as our knowledge of science advances, it raises questions about both the ethics of scientific investigation and its uses. The importance of the relationship between science and ethics has been known for centuries, but the discoveries and technologies of the late twentieth century require decisions in increasingly complex areas such as genetic screening, human reproduction and global warming.

For those involved in science education this has led to a demand for practical advice on teaching the ethical aspects of science. A new book edited by Patrick Fullick and Mary Ratcliffe of the University’s School of Education aims to address this need and to encourage an awareness of the ethical dimensions in both the conduct and use of science.

Entitled Teaching Ethical Aspects of Science, the book is an outcome of the School of Education’s Science, Ethics and Education Project, which was established to produce practical advice for teachers. The project, which has funding from the International Council of Scientific Unions, has brought together the expertise of curriculum developers from around the world.

The authors emphasise the distinction between providing and analysing evidence (that is when science operates) and acting on that evidence (when ethics operates). The role of ethical analysis in dealing with science-based personal and social issues is also highlighted.

In his preface to the book, project director Professor Kelly writes:

Scientific discoveries have led to technological applications which have immense social and personal implications. Global change, human genome research, reproductive technologies and nuclear technologies are examples of such current topics of concern. They beg questions both of social policy and personal attitudes and behaviour.

The answers lie in science—to determine what we can do. Technology, economics and socio-cultural issues will also need to be considered; but, as crucial, is a consideration of ethics—to aid us in determining what we ought to do.

As well as containing curriculum materials that can be used to illustrate and develop themes concerned with ethical aspects of science, the book aims to stimulate awareness of ethical analysis as a rigorous mode of thought and to prevent discussion of moral aspects of science-based issues being merely a diffuse gathering of opinions.

The material will prove useful to science educators around the world in examining this important aspect of the conduct and use of science.

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PROFESSIONAL DEVELOPMENT INSTITUTES FOR 1998

Science and Mathematics Education Centre (SMEC), and the National Key Centre for Teaching and Research in School Science and Mathematics, Curtin University, Perth, Western Australia announces its Professional Development Institutes for 1998

During 1998, the National Key Centre for School Science and Mathematics will offer TEN more of its highly successful professional development institutes for science, mathematics and technology educators.

Six institutes will be held in Australia and four will be held in overseas locations. Details of institutes are available at http://www.curtin.edu.au/curtin/dept/smeg/institut.htm

Brief details are listed below:

1. Learning Environments in Science, Mathematics and Technology Education
   Associate Professor Darrell Fisher, Curtin University of Technology

2. Special Topic: Writing a Thesis Proposal
   Associate Professor Darrell Fisher, Curtin University of Technology

3. Constructivist Approaches to Teaching and Learning
   Dr. Peter Taylor, Curtin University of Technology
   24-28 February 1998, National Kaohsiung Normal University, Kaohsiung, Taiwan

   The Key Centre is collaborating with the National Kaohsiung Normal University in the provision of this institute.

4. Classroom Climate in Science, Mathematics and Technology Education
   Professor Barry Fraser, Associate Professor Darrell Fisher, Curtin University of Technology
   22-26 June 1998, Universiti Brunei Darussalam

   Jointly sponsored by the Sultan Hassanal Bolkiah Institute of Education, Universiti Brunei Darussalam, this institute will be held in conjunction with a conference on science, mathematics and technology education at Universiti Brunei Darussalam during 29 June-2 July.

5. Teaching Science for Understanding
   Professor Sandra Abell, Purdue University, USA
   13-17 July 1998, Curtin University of Technology, Perth, Western Australia

6. Action Research for Science, Mathematics and Technology Teachers
   Dr. John Wallace, Dr. Peter Taylor, Curtin University of Technology
   13-17 July 1998, University of the Northern Territory, Darwin, Northern Territory

   The Key Centre is collaborating with the University of the Northern Territory in providing this institute.

7. Assessment and Evaluation in Science, Mathematics and Technology Education
   Professor Leonie Rennie, Professor Barry Fraser, Curtin University of Technology
   27-31 July 1998, Wright-Patterson Air Force Base, Dayton, Ohio, USA

   The Key Centre is collaborating with Miami University, Ohio, USA, in providing this institute.

8. Leadership and Professional Development in Science, Mathematics and Technology Education
   Dr. John Wallace, Curtin University of Technology
   14-18 September 1998, Department of Education, Community and Cultural Development, Hobart, Tasmania

9. Constructivist Approaches to Teaching and Learning
   Dr. Peter Taylor, Curtin University of Technology
   14-18 September 1998, Curtin University of Technology, Perth, Western Australia

10. Improving Teaching and Learning in Science, Mathematics and Technology
    Professor David Treagust, Curtin University of Technology
    Professor Reinders Duit, University of Kiel, Germany

    The Key Centre is collaborating with the Auckland College of Education in providing this institute.

    Dr. Bruce Waldrip
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FIFTH INTERNATIONAL HPSST CONFERENCE
Pavia University
September 15-19, 1999

The International History, Philosophy and Science Teaching Group is holding its Fifth International Conference at Pavia University, northern Italy, September 15-19 (Wednesday -Sunday), 1999.


The 1999 conference is being held in conjunction with the European Physical Society’s Interdivisional Group on History of Physics and Physics Teaching. This group has been meeting biennially since its first conference at Pavia University in 1983. The joint conference will contribute to local celebrations of the bicentenary of Alessandro Volta’s creation of the battery at Pavia University in 1799.

The conference will follow, and overlap with, the 4th European Physical Society’s Conference on History of Modern Physics. A joint session of the two conferences will be held on the Wednesday.

Part of the conference will be held at the Centro di Cultura Scientifica ‘A. Volta’ on the shores of Lake Como, and underneath the Italian Alps. The non-profit Centro is devoted, in part, to educational and interdisciplinary aspects of science.

CONFERENCE PAPERS

The International Group is concerned to promote the improvement of school and university science teaching by making them informed by the history, philosophy, and sociology of science and of education. It has a particular interest in bringing these spheres of knowledge into teacher education programmes, and in applying considerations from the history and philosophy of science to theoretical and pedagogical issues in science education, including science education research.

Scope. Papers dealing with theoretical or pedagogical issues in science teaching. Thus historical and philosophical papers are welcome provided effort is made to bring out the educational dimension or implications of the research.

Publications & Deadlines. The conference organisers hope to continue the practice of earlier conferences and provide Conference Proceedings to all attending the conference. It is also anticipated that some scholarly journals will run special issues devoted to papers being given at the conference.

Because of production schedules, papers to be considered for journal publication (after standard review processes) need to be submitted to the organisers by May 1st, 1998. Papers for conference presentation and for inclusion in the Proceedings, need to be submitted in their final form by May 1st 1999.

The Preliminary Notification should be completed as soon as possible, and prior to submitting a paper. Papers will be reviewed as they are received, thus the earlier they are submitted, the earlier acceptance decisions can be communicated.

Submission. Papers should not exceed 5,000 words in length. Four copies, along with a disk version (Mac or Apple), need to be submitted by the above deadlines (May 1, 1998 for preconference journals; May 1, 1999 for conference presentation and inclusion in Proceedings). An ‘About the Author’ statement should also be included, taking the form of: Present Position, Education, Major Publications and/or Research Interests and/or Teaching Responsibilities.

Format and Style. Papers are to follow the format and style used in the Group’s journal Science & Education. Pay particular attention to title (bold), author (capitals), address (italics), Abstract (70-100 words), headings (capitals, not underlined and not in bold), and bibliographic conventions. Detailed guidelines, along with Permission to Publish forms, will be sent on receipt of attached Preliminary Notification. Papers must comply exactly with style guidelines in order to be considered for publication in either journals or Proceedings.

Conference Organisation. The chairperson of the local organising committee is Professor Fabio Bevilacqua of the Physics Department, ‘A. Volta’, at Pavia University. He and colleagues have been working since 1983 on ways of informing science teaching through use of the history and philosophy of science. They have created the multimedia Pavia Project Physics course which embodies history of science, and is framed on philosophical ideas about theory development and testing in science, and on considerations of how children learn science. An International Advisory Committee will assist with conference planning and programme content. School teachers and graduate students are especially encouraged to attend and contribute to the conference.

Please return as soon as possible to:
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E-mail: volta99@pv.infn.it
web page: www.cilea.it/volta99

For additional information you may also contact:
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Science Education International, Vol. 8, No. 4 December 1997 37
May 2-10, 1998
National Science Week 1998
U.S.A.

The theme for schools will be: Oceans

July 5-10, 1998
CONASTA 47
Northern Territory University, Darwin

Science Education—Beyond the Horizon
The 1998 conference will be hosted by the Science Teachers Association of the Northern Territory (STANT Inc.). The conference is designed to provide a forum where all science educators; whether in primary, secondary, senior secondary or teacher education, have an opportunity to reflect and examine the important issues confronting education today and in the future. Issues of a geographical, cultural, political and a technological nature centering on student learning will feature throughout the conference program. The sub-themes will give all interested in science education the opportunity to reflect on their practices and gain insight into what is waiting for us “beyond the horizon.”

It is planned that prominent Australian and international educators, as well as experienced and enthusiastic classroom teachers will provide a stimulating environment where keynote addresses, seminars, workshops, discussion groups, forums and excursions allow professional enlightenment.

Further details are available from the conference website at: http://www.topend.com.au/~stant/conasta.htm or write to:
CONASTA 47 Secretariat
PO Box 778
Nightcliff
Northern Territory 0814 AUSTRALIA

For more information, please contact:
Conference Office
ASE, College Lane
Hatfield, AL10 9AA
Fax: 01707 266532
E-mail: ase@asehq.telme.com

March, 1998
Science & Society: Technological Turn
An International Conference on STS
Japan

Topics to be discussed include the following:
• Network assessment of science
• Transnationalization of Corporate Science
• Technology and Media
• International Relation in the Post-Nuclear Age
• Science and Technology in Asia
• Implication of STS on Science Education, Science Education Policy and Human Resource

Among the invited speakers are: Michel Callon, Sheila Jasoff, Deepak Kumar, Morris Low, Brian Martin, Arie Rip, Rustum Roy, Song Sang-Youg, Peter Weinart, and Robert Yager.

For more information, please contact:
Conference Office
c/o Prof Shin-ichi Kobayashi
Graduate School of Information Systems
University of Electro-Communications
1-5-1, Chofugaoka
Chofu, Tokyo 182 JAPAN
Fax: +81-424-85-9843
E-mail: sts@kob.is.uec.ac.jp
http://hostcinf.shinshu-u.ac.jp/stsconfjp.html

January 8-10, 1998
Enhancing the Teaching of Science
The Association for Science Education (ASE) Annual Meeting
The University of Liverpool, U.K.

• 280 Talks and Workshops
• 300 Exhibitors
• 40 Science Lectures
• 10 Social Events
• 20 Visits
• 90 Courses

June 3-5, 1998
THE UtreCHT/ICase SYMPOSIUM
Utrecht University, the Netherlands

The Utrecht/ICASE international symposium on science education will be held at Utrecht University as a follow-up to our very successful symposia at Dortmund University. Like the Dortmund Symposia, the Utrecht symposium will be organized in cooperation with the International Council of Associations for Science Education (ICASE).
The key theme of the conference will be:
**Bridging the gap between theory and practice: What research says to the science teacher**

For more information, please contact:
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**July 25-28, 1998**
**Making Curricular Connections in the K-8 Classroom Summer Institute jointly sponsored by the National Science Teachers Association and National Council for the Social Studies**
Northern Arizona University
Flagstaff, Arizona

Join teacher leaders in this unique participatory institute on curricular integration featuring science and social studies. Working sessions based on presentations by nationally-known experts will provide opportunities for dialogue and application. Topics for exploration include: multiple intelligences, standards-based practices, service learning, performance-based assessment, thematic instruction, project-based learning, planning and managing integration, issues oriented learning, and literature connection.

For more information, please contact:
NSTA
Conventions Department
1840 Wilson Blvd.
Arlington, VA 22201-3000
703-243-7100, ext. 227
corporateconventions@nsta.org
www.nsta.org

NCSS
Conference Department
3501 Neward St., NW
Washington, DC 20016
800-296-7840, ext. 108
conference@ncss.org
www.ncss.org

**February 26-28, 1998**
**International Consortium for Research in Science and Mathematics Education (ICRSME)**
**7th Consultation**
St. Clair, Trinidad

The International Consortium for Research in Science and Mathematics Education (ICRSME) is holding the 7th International Consultation from February 26 - February 28, 1998 in St. Clair, Trinidad. St. Clair is in the Port of Spain metropolitan area. The meeting will be co-hosted by the science and mathematics education community of Trinidad & Tobago and The Ohio State University represented by Donna Berlin and Arthur White in Columbus, Ohio. The program will provide opportunities to share favorite ideas and programs, make new friends and renew old friendships, get some much needed vacation time, pick up some new ideas and refine some collaborative research and development projects.

For additional information please contact either:
Dr. Arthur L. White or Dr. Donna F. Berlin
Math, Science, & Technology Education (MSAT)
238 Arps Hall
The Ohio State University
1945 North High Street
Columbus, Ohio 43210-1015 USA

**March 23-26, 1998**
**International Conference for Environmental Educators**
Pretoria, South Africa

Vista University and the University of South Africa (UNISA) would like to extend an invitation to educators to attend this international conference for environmental educators. The conference seeks to discuss the holistic role of environmental educators at universities, colleges of education, non-governmental organisations as well as those in business and industry.

**Theme**
There has been a growing realisation that environmental problems cannot be solved without keeping social, economic and political aspects in mind. The contrast between the so-called western and pre-modern worlds, often referred to as the first and third worlds, was highlighted during the Earth Summit in Rio. It is essential that these “worlds” work together to address environmental problems. Environmental educators at post-school level need to adjust their education programmes to address EE in both worlds and so work towards a global solution. The conference aims to discuss the role of these educators and to seek answers to questions such as: Are there different approaches to EE in western and pre-modern worlds? How could strategies be co-ordinated to both?

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Science Education International, Vol. 8, No. 4 December 1997
NSTA Conventions: (More details to come.)

April 16-19, 1998
National Convention in Las Vegas, Nevada

March 25-28, 1999
National Convention in Boston, Massachusetts

April 6-9, 2000
National Convention in Orlando, Florida

March 22-25, 2001
National Convention in St. Louis, Missouri

1999
The 11th ICASE Asian Symposium
the Philippines

For more information, please contact:
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Bicutan, Taguig
Metro Manila, PHILIPPINES
Fax: 63 2 837 1924

May 17-21, 1999
National Science Week 1999
U.S.A.

The theme for schools: Time

July 4-9, 1999
CONASTA 48
Adelaide, South Australia

Theme: The spirit of science

August 1999
IOSTE/GASAT Conference
Durban, South Africa

July 5-9, 1998
SCICON 98, The Eleventh Biennial Conference of
the New Zealand Association of Science Educators
(NZASE)
Nelson, New Zealand

For more information, please contact:
SCICON
Conference & Events
PO Box 1254
Nelson, New Zealand
Phone: 64 (0)3 5466022
Fax: 64 (0)3 5466020
E-mail: scicon@confer.co.nz
Website: http://nzase.org.nz/scicon/htm

September 15-19, 1999
Fifth International HPSST Conference
Pavia University, Italy

The conference is being held in conjunction with the
European Physical Society's Interdivisional Group on
History of Physics and Physics Teaching. The joint
conference will contribute to local celebrations of the
bicentenary of Alessandro Volta's creation of the battery
at Pavia University in 1799.

The conference will follow, and overlap with, the 4th
European Physical Society's Conference on History of
Modern Physics. A joint session of the two conferences
will be held on the Wednesday.

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July 14-18, 1998
The Second China-U.S. Conference on Education
Beijing, China

If you are interested in expanding our professional
network and interacting with counterparts in the People's
Republic of China, we invite you to submit a paper or
to attend as an active participant.

November 18-22, 1998
European Researchers in Didaktik of Biology
Conference
University of Goteborg, Sweden

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Extending and improving education in science for all children and youth by assisting member associations throughout the world

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ICASE Homepage: http://sunsite.anu.edu.au/icase
Science Education International is the quarterly journal of the International Council of Associations for Science Education. ICASE was established in 1973 to extend and improve education in science for all children and youth by assisting member associations throughout the world.

This journal provides a means for associations, institutions, centres, foundations, companies and individuals concerned with science education, to share perspectives, concerns, ideas and information which will foster cooperative efforts to improve science education, and which will serve as a chronicle of the advancement of science education throughout the world.

**Editor**
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**Contents**

ICASE News .................................................. 2

**Science Education Around the World**
The primary school curriculum: policies of environmental education in Bangladesh
Quazi Afroz Jahan Ara, Bangladesh ...................... 15

**Teaching Materials and Strategies**
Encouraging use of practical work in primary schools
Sue Fisher, The Gambia ..................................... 17
The teacher's role in inquiry-centred experiences
JoAnne Vasquez, USA ....................................... 21

**Science Teacher Education**
Supporting change of science and technology teacher preparation in the Asian region
Lucille Gregorio, Thailand ................................. 25

**Non-formal and Informal Science Education**
Evaluation of clientele impact of science exhibits
Vivien M. Talisayon, Philippines ............................ 31

**Calendar** .................................................... 38

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Compiled by Jack Holbrook (Secretary), Brenton Honeyman (Past President) and Robin Groves (Editor, SEI)

The Seventh ICASE General Assembly was held in Liverpool, UK on 6/7 January 1998. This was the first full meeting of ICASE since 1993, and this edition of Science Education International contains several items and reports from that meeting.

New Constitution for ICASE

Members at the ICASE General Assembly in Liverpool voted to accept a new ICASE Constitution. This was the culmination of a two year period of review of ICASE operations, involving consultations with all executive officers and member associations. The General Assembly expressed its appreciation for the careful process of consultation between the Executive Committee and member organisations. The Executive Committee would like to thank member organisations for their support and, in particular, the executive team members who developed the new constitution – John Anderton, Dennis Chisman, Anna Garner, Jack Holbrook and Brenton Honeyman.

The new constitution provides for an increased role by ICASE member organisations in the governance of ICASE, and more efficient management by and clearer accountability on the part of the members of the ICASE Executive. It provides for an executive structure ready to incorporate a permanent secretariat should this become financially viable. The new constitution has reduced the period between General Assemblies from four years to three years.

Copies of the new ICASE Constitution can be obtained from the ICASE website <http://sunsite.anu.edu.au/icase> or by requesting a printed copy from the ICASE Executive Secretary, PO Box 6138, Limassol, Cyprus.

New ICASE Executive Committee

The ICASE General Assembly in Liverpool elected a team of new and continuing officers to the Executive Committee for the next term of three years.

Management Committee

Ms Anna Garner (previously President-Elect) was instated as President (1998-2000). At the time of her election to the position of President-Elect in 1993, Anna was the President of the Icelandic

Anna Garner (ICASE President, Norway), Cheng Donghong (CAST, China) and Jack Holbrook (ICASE Secretary, Cyprus)
Science Teachers Association. Since then, Anna has played a key role in several science education projects and events across Europe, including the highly successful CEHC-ICASE Industry-Science Education Symposia. During her term as President-Elect, Anna completed an extensive revision and update on the ICASE Guidebook for Science Teachers Associations, contributed to the development of the new ICASE Constitution, spearheaded ICASE’s involvement in the 1999 Schools Links Project, and played a leading role in many other ICASE initiatives. She now resides in Norway, teaching at the Red Cross Nordic United World College in Flekke.

Mr Brenton Honeyman (previously President) became Past President (1998), a position that, under the new constitution, ceases one year after the General Assembly. Brenton lives in Canberra, Australia and is the International Programs Manager at Questacon, Australia’s National Science and Technology Centre.

Ms JoAnne Vasquez was elected as the new President-Elect (1999-2000). Under the new constitution, this appointment commences one year after the General Assembly. JoAnne Vasquez works at the Science Resource Center, Mesa Public Schools, Arizona, USA and is the Retiring President of NSTA.

Dr Jack Holbrook was elected to the position as Secretary (1998-2000). Jack, previously a Vice President and Executive Secretary of ICASE, will continue to provide the secretariat services under the terms of the new constitution. The office of the Secretary is in Cyprus.

Mr Patrick Whittle was elected as Treasurer (1998-2000). Patrick, an experienced international education consultant based in the UK, brings to the ICASE team an extensive background in working with science teacher associations in developing countries in Africa and Asia.

Executive Committee
The Executive Committee comprises members of the Management Committee and the following regional representatives elected at the General Assembly:

African Representative: Chief Bassey Albert Nyong, Nigeria
Asian Representative: Dr Janchai Yingprayoon, Thailand
Australasian Representative: Mr John Anderton, Australia
European Representative: Ms Miia Rannikmae, Estonia
Latin American-Caribbean Representative: Prof Marta Cristina Moyano, Argentina
North American Representative: Dr Joe Peters, USA

Bob Lepischak CASE, Canada, JoAnne Vasquez (NSTA, USA) and Brian Atwood (ASE, UK) following the election of ICASE Officers at the General Assembly.

The following standing committee chairpersons were appointed by the Executive Committee to serve on the Executive Committee:

ICASE Journal: Mr Robin Groves, Australia
Pre-Secondary Science: Dr Sue Dale Tunnicliffe, UK
Finance Development: Mr David Standley, UK
Publications and Communications: Joseph Depireux, Belgium
Project 2000+: Dr Jack Holbrook, Cyprus
Ad Hoc Committees

Several Ad Hoc Committee Chairpersons were appointed by the Executive Committee. These are non-Executive Committee positions:

Safety Project: Dr Kenneth Russell Roy, USA
Secretariat Project: Mr Dennis Chisman, UK
1999 International School Links Project: Ms Caroline McGrath, UK
International College of Science Education Project: Mr John Anderton, Australia
International Consultancy Network Project: Mr Brenton Honeyman, Australia

Contact addresses of Executive Committee officers are listed on the inside front cover of this journal. Contact details are also published on the ICASE website <http://sunsite.anu.edu.au/icase>.

New ICASE Journal Editor

The ICASE Executive is pleased to announce that the editorial team of Science Education International will be led by Mr Robin Groves, an Education Consultant based in Perth, Western Australia. Robin has had a long and distinguished involvement in administering science teacher association activities at local, national and international levels. He has considerable experience in science education publishing through his involvement as Feature Papers Editor of the Australian Science Teachers Journal and producer of several science education publications. He was appointed as the founding Executive Director of the Australian Science Teachers Association in 1991 at the time of establishing a fulltime national secretariat and held this position until 1997. Robin is now undertaking a range of education consultancies.

Thank you to Dr Ron Bonnstetter and to his editorial team who have most capably produced the ICASE Journal during the past four years. Their efforts have been significant, not only in terms of the amount of time they have freely given to this task, but also in terms of what Ron and his team have chronicled for the professional benefit of readers and the member organisations of ICASE. This quarterly journal continues to be a high profile vehicle for communicating science education thought and practice throughout the world and we are indebted to Ron Bonnstetter and his team for their outstanding contribution.

First meeting of the newly elected ICASE Executive Committee. January 1998
It is important to record the outstanding efforts of two leading ICASE Executive Committee members whose roles are changing in 1998.

Dennis Chisman

Dennis Chisman can be considered as the ‘father of ICASE’. Although the origins of ICASE can be traced back to a UNESCO regional workshop on integrated science teaching held in the Philippines in 1970, ICASE was formally established in 1973 at the University of Maryland, USA. At that time Dennis was appointed as the first Executive Secretary and Treasurer, a position he held through three ICASE General Assemblies until 1985. From 1985 until the Seventh ICASE General Assembly recently concluded in Liverpool, UK, Dennis continued on the ICASE Executive Committee as the appointed Honorary Treasurer. All in all Dennis has been an ICASE officer for 24 years, a feat unlikely ever to be matched in the future. Dennis has not cut his ties completely, however, as he continues to work for ICASE by chairing an ad-hoc committee to explore setting up an ICASE secretariat.

Dennis’s unparalleled experience and wisdom will be sorely missed by the ICASE Executive. He was directly involved in setting up all ICASE General Assemblies and in getting the series of hugely successful ICASE Asian Symposia off the ground with the very first, held in Delhi, India in December 1977. Dennis played a major role in planning and running two major international integrated science conferences in the 1970s, both sponsored by UNESCO. The first was held in Oxford, UK in 1975 and was concerned with the evaluation of integrated science education and the other, in Nijmegen, Netherlands on trends in integrated science.

Dennis’s involvement on the international science education scene continued through the 1980’s, not only for ICASE events, but also for other large international events in which he succeeded in involving ICASE. He was very much involved with the ICSU CTS conference in Bangalore, India held in 1985 on science education and future human needs, with editing New Trends in Integrated Science, Vol VI, a UNESCO publication arising from an integrated science seminar in Australia in 1988, and in being treasurer to chemical education conferences in York, UK in the 1990s.

Many ICASE member organisations exist in the developing world and maintaining communication with all member organisations was undoubtedly a major task. Dennis handled his very time-consuming task voluntarily and often initiated follow up matters at his own expense. There can be no doubt that ICASE is where it is today, in no small part thanks to the enormous dedication and hard work undertaken by Dennis.

Brenton Honeyman

Brenton Honeyman steps down as ICASE President after four years at the helm, when he took up the challenge of leading ICASE into new vigorous times. This followed a very successful four years as the ICASE Journal Editor where he pioneered Science Education International and set it up as a truly recognised international science education journal. The amended ICASE constitution, agreed upon at the last ICASE General Assembly, is a major example of how Brenton has guided Executive Members and member associations towards a new direction and set ICASE up as a more professional organisation with clear goals and involvements.

Under Brenton’s leadership ICASE has pioneered major links with Latin America and succeeded in helping member associations there to publish a first ICASE Journal in Spanish. ICASE has also become firmly associated with Project 2000+, as UNESCO struggles with its internal financial difficulties, and Brenton has taken this message around the world, none more so than in the STS conference organised by KEDI in Seoul, Korea in 1997 and the 2nd ICASE Latin America Symposium in Mar del Plata, also in 1997.

Brenton also helped to establish ICASE links with UNESCO at the primary education level and ran a very successful workshop in Kingston, Jamaica developing primary science education materials.
Extracts from the Executive Secretary's report at the 7th ICASE General Assembly

by Jack Holbrook

(a) ICASE Membership

At the General Assembly membership was stated as 148 member organisations.

From these figures you can see that ICASE continues to grow as countries in Eastern Europe start to form Associations and ICASE makes contact with organisations in Latin America.

The fastest growing category continues to be institution members (77% growth).

(b) Communication

With this great increase in membership, communication continues to be, as is to be expected, problematic.

An increasing aid to communication over the last four years has been email. Much correspondence between Executive Committee officers is in this manner and it is hoped this can be extended to ICASE member organisations as well.

(c) Conferences, symposia and workshops carrying the ICASE name, held since 1993

6. STL Teaching Material Workshop, in conjunction with UNESCO and PASE, Lahore, Pakistan, April 1997.
7. 10th ICASE Asian Symposium, Lahore, Pakistan, April 1997.
8. STL Teaching Material Workshop, in conjunction with UNESCO and Club de Ciencias lAlbert Einstein, Mar del Plata, Argentina, April 1997

d) World Activity Day/Week

Since the last General Assembly, an Activity Day was held in October 1993 and an Activity Week in October 1995. Both were geared to involve students in projects and were welcomed in some countries. Certificates were awarded to participating schools.

e) ICASE International Distinguished Awards

The 9th Award, mentioned in the last General Assembly report and awarded to Professor Sam Bajah in 1993, was presented in Nigeria at the 1994 annual meeting of STAN.

The 10th ICASE Award was given in 1994 and presented in 1995 to Dr Hans Jurgen Schmidt at the 1995 annual meeting of MNU. In 1996, the 11th Award was made to Professor Robert Yager and presented in Korea in 1997. No award was made in 1997.

f) ICASE Stepping into Science Project

This project for primary science continues to be promoted through the ICASE primary science newsletter. More details about the development of this project are reported in the minutes of the General Assembly sent to each ICASE member organisation.
(g) Publications since the 1993 General Assembly

It has become increasingly difficult for ICASE to continue publications to its members and the earlier series of commemorative issues and yearbooks has now ceased in favour of a quarterly newsletter and a primary science newsletter.

Regional ICASE newsletters were produced in Europe (three issues) and in Africa (one issue) and sent to ICASE member organisations in these regions to keep them abreast of news and developments.

The following publications, carrying the ICASE logo, have been produced since 1993.

ICASE Books

Reports of Workshops/Symposia

Documents Produced for UNESCO under Contract

(h) New Projects

By far the major initiative taken by ICASE to follow up Project 2000+ is an attempt to operationalise scientific and technological literacy for all (STL) in the classroom. With Project 2000+, ICASE has taken the lead and is now wishing to persuade STAs on the future direction for science teaching.

The Project has initiated concern for STL teaching materials. ICASE has run four STL workshops in the last two years, all with UNESCO and a local member association partner. These workshops have aimed to:
1. Promote an STL philosophy befitting the 21st century in which the purpose of teaching science subjects is clearly addressed.
2. Create STL teaching materials that can be used directly in the classroom.
3. Provide in-service training to the workshop participants on STL by means of the hands-on creative activity of writing materials.
4. Stimulate subsequent piloting of the materials in the classroom (worldwide if applicable).
5. Consider the dissemination of the materials and the initiation of other workshops promoting the STL criteria.

A major difference with STL materials is that in
science lessons, teaching science concepts is essential, but not enough. Making lessons interesting is important, but not enough. Promoting student-centred teaching is important, but not sufficient. Also needed in science lessons are the development of personal skills, social values and the scientific method. All of these constitute science teaching for the 21st century in striving for STL (scientific and technological literacy for all).

(i) ICASE - 25 years

Finally, it is worth mentioning that this year marks the 25th anniversary of ICASE. ICASE was founded in 1973 at a seminar in Maryland, USA. Most of the founding members associations continue to be members of ICASE.

Extracts from the Honorary Treasurer’s report by Dennis Chisman

Every year since ICASE was established has been difficult from the financial point of view. 1997 is no exception. Although the 1997 account shows a positive balance, there are still outstanding bills to be paid, including the cost of the General Assembly meeting in Liverpool and the printing of the December issue of the journal.

The incomes for subscription from all categories of members in 1997 amounted to about US$13,000, which is less than 1996 (US$15,500). Income from UNESCO contracts was $21,500 for 1997. About half of this was contracted for a Project 2000+ steering committee meeting in May. Most of the balance was for the development of a Resource Kit.

The reality is that the total income from members' subscriptions and journal subscribers is just enough to pay for the direct costs of printing and posting the journal and for the direct costs for the Executive Secretary and the Treasurer in the day-to-day running of ICASE. Without grants or contracts from UNESCO or elsewhere it would be impossible to meet even modest expenses of the officers and the Executive Committee for regional activities or for international meetings. There has not been a full meeting of the Executive Committee during the last four years because of financial constraints.

The real costs of running ICASE are much greater than those shown in the official statement of accounts, since many of the Executive Committee and the officers contribute directly or indirectly, personally or through their organisations and employers, considerable sums to support the work of ICASE. In addition ICASE has received generous support from member organisations such as the ASE (UK). For example the ASE printed and posted all four issues of the STEP newsletter in 1997.

Questacon – The National Science and Technology Centre in Australia has generously supported the President with office facilities and support.

The subscription rates for members in all categories and the subscription rates to the journal and the primary newsletter have not changed significantly in recent years. There is a case for raising the rates and the following are recommended for 1999 onwards:


Associate members: As for full members up to 1000 members; thereafter US$50 less.

Institution members: US$150

Company/Foundation members: No change

Journal subscription: US$25 Individual (UK£16)

US$50 Library (UK£32)

These rates were duly adopted by the Executive Committee at its meeting following the General Assembly.
An abridged version of the ICASE President's Report to the 7th ICASE General Assembly held in Liverpool, UK, 6 January 1998

By Brenton Honeyman, President of ICASE (1993-97)

Introduction

To all members of the Executive Committee and to all the individuals and organisations who have contributed to the work and development of ICASE and its activities during my four years of office, I wish to express my sincere thanks. As a voluntary organisation, ICASE continues to make a significant impact not because it has huge resources but because it involves dedicated people who are willing to contribute generously of their time, talents and skills.

The years 1993 to 1997 have been significant in the growth and development of ICASE. 1993 marked the twentieth year of ICASE, providing us with an opportunity not only to review and celebrate past achievements, but also to consider how best this worldwide organisation might move forward and build upon these accomplishments.

In establishing a Development Plan, the ICASE Executive Committee identified five major areas for development.

1. Profile and image of ICASE: to establish ICASE as an advocate for science education in the global community, working with its members to enhance the quality of science and technology education for all.

2. Policy development and operations: to develop policies and operational procedures to facilitate existing programs, and to more effectively address and respond more effectively to new challenges.

3. Financial base: To strengthen the financial base of ICASE so that the Council is able to fulfil its programs.

4. Enhancing support for ICASE members: to expand existing services, and to develop new services to meet the evolving needs of member associations, institutions, centres, foundations, companies and individuals with an interest in science education; to initiate research and development projects relating to anticipated future needs of ICASE members.

5. Human resources: to identify and involve science educators and others in assisting the Council to carry out its initiatives; to develop support links with other international non-governmental and governmental organisations.

This report covers some of the highlights made in relation to these areas of development.

Profile and image of ICASE

The International Forum on Scientific and Technological Literacy for All, held in Paris in July 1993, had just concluded as the last General Assembly met to consider the focus and direction of ICASE during its next term of office. As a key initiate of Project 2000+, ICASE pledged that it would continue to play a key role in stimulating and supporting follow-up action in this worldwide program. The goals of Project 2000+ were seen to closely reflect the rationale which had led to the formation of ICASE twenty years previously, and so ICASE was in a position of readiness to raise awareness about this global venture and to plan programs to provide much needed direction and interpretation on how member science teacher associations and science education institutions, and even individual teachers within their classrooms, might contribute to scientific and technological literacy (STL).

Accordingly, ICASE joined with its Project 2000+ partners (UNESCO, The World Bank, UNICEF, UNDP, UNEP, Commonwealth Secretariat, ICSU, IOSTE, GASAT and WOCATE) to work towards the challenge of realising STL for all children, youth and adults. Progress to date, however, has largely been due to the individual efforts rather than the combined efforts of Project 2000+ partners. A meeting of most Project 2000+ consortium members in May 1997 made some progress to revitalise a consortium approach, and agreed that a more regular forum for consortium members to plan and review initiatives would help to regain the momentum of Project 2000+.

ICASE has, through its enthusiastic commitment to this global project, gained the highest respect of the international community for its capacity to provide quality programs to support the curriculum reform efforts of many countries. One of the most exciting developments has been in the area of workshops that involve local educators and curriculum officers in the production of classroom resources based on the need to enhance scientific and technological literacy.

Following the success of a pilot workshop in Vanuatu to develop activities for trialling in local primary and secondary classrooms, ICASE has organised and led several workshops to familiarise teachers and curriculum developers with curriculum approaches.
congruent with STL goals.

Regional ICASE conferences and symposia in Asia, Latin America, Europe as well as ICASE contributions to international and regional meetings in Africa, Asia, Australasia, Europe, North America and Latin America have all played their part in strengthening the profile and activities of ICASE.

Policy development and operations

The Executive Committee has carried out a review of its structure and operations. A revised constitution has been developed by John Anderton and members of the Executive Committee, paving the way for an increased role by ICASE member organisations in the governance of ICASE, and more efficient management by and clearer accountability on the part of the members of the ICASE Executive.

One of the most pressing needs is to establish a permanent secretariat for ICASE. The Executive has been exploring options to establish a secretariat base with at least some of the costs met by another professional organisation, an industry body or an inter-governmental organisation.

In order to contain expenditure, only one meeting of the full Executive Committee was held – in Lancaster, January 1995 – between General Assemblies. A number of mini-executive meetings have been held in conjunction with various conferences to enable a few members of the Executive to focus on particular agenda items, thereby keeping the momentum flowing on major projects.

During this term, there has been a growth in the use of the internet by Executive Committee members to maintain contact, communicate updates on their projects and share ideas. The internet is becoming an important tool for keeping ICASE operations and projects on the move and provides our most affordable option yet to traverse the great distances around the globe.

Financial base

Funding to support ICASE operations comes from three major sources:

1. Membership and journal subscriptions: While celebrating a growth in membership, ICASE continues to have to find ways of coping with the challenge of providing services to members who, often for understandable reasons, are not able to arrange payments for subscriptions. The ICASE Journal, while continuing to be very much appreciated by library and individual subscribers, has not yet attracted sufficient subscriptions to be fully cost recoverable. Yet, the ICASE Journal has the potential to earn useful additional revenue to support other areas of ICASE activity.

2. Project funding grants from organisations such as UNESCO and the Commonwealth Secretariat: Whenever such project funds become available, ICASE officers work in a voluntary capacity so that ICASE can retain the administrative fee component of the funding grant. Such grants are critical to maintaining the operations and activities of ICASE. The levels of these grants are never sufficient to outsource expertise beyond ICASE officers at normal consultancy rates; hence the workload always falls to those ICASE officers or individuals who are willing to carry out such projects voluntarily. Grants from a number of local, national and international organisations contribute greatly to the success of ICASE Regional Symposia, often enabling a wider participation from across the region.

3. In-kind contributions from organisations and individuals: The Association for Science Education has kindly met the cost for printing and distributing the ICASE Primary Newsletter 'Stepping into Science'. Organisations such as the ASE and NSTA provide support for ICASE officers participating in their national meetings. Other organisations provide in-kind support in terms of office facilities and services to support the operations of ICASE officers.

One of the special aspects of ICASE, as a voluntary organisation, is that its officers and those who work within the organisation are strongly motivated to do whatever they can for the benefit of the organisation and its members, often giving generously of their time and even their own finances to ensure that ICASE continues to be as effective as possible.

This spirit is no better demonstrated than in the life of Sheila Haggis, who was acknowledged for her outstanding contributions through the award of the ICASE Distinguished Service Award. Sheila had been instrumental in the establishment of ICASE in 1973 and had been active in the establishment and support of so many science teacher associations throughout the world. Sadly, Sheila passed away in 1995 as a result of an illness she kept to herself. From her estate she bequeathed an amount of
£10,000 to ICASE. It is through such generous and selfless support that ICASE was founded and continues to flourish. The Executive is considering how best to use this gift from Sheila Haggis so as to perpetuate her memory.

Strengthening the financial base of ICASE is essential if we are to accomplish the ambitious agenda before us. There is much potential to build on emerging partnerships with business and industry, and to strengthen our links with UNESCO and other international bodies in order to facilitate the work of ICASE.

Enhancing support for ICASE members

ICASE continues to maintain member services such as the ICASE Journal. Ron Bonnstetter and his team deserve our special thanks for capably taking on the task of producing Science Education International, the quarterly journal of ICASE and a key publication in sharing science education ideas and perspectives from around the world. Similarly, Sue Dale Tunnicliffe, Norman Lowe and their team continue to make a valuable contribution to the support of primary science education through the production of STEPS International, the primary science newsletter of ICASE.

Sue Dale Tunnicliffe and a network of primary science educators continue to conduct workshops and share resources at conferences and gatherings of teachers of primary science, and to support the Stepping into Science Award Program for students. Through these programs, ICASE is making a strategic effort to support countries in their development and implementation of primary science.

Several new ICASE publications have been produced including Primary Science Activities Around the World: Sourcebook 1, Proceedings of the Eighth ICASE Asian Symposium, Proceedings of the 1994 Seminar on Problem Solving and Misconceptions in Chemistry and Physics, and the Proceedings of the 1996 Seminar on Research on Science Teaching and Learning. ICASE facilitated the production of the Science in Space teaching units by the ASE, and prepared manuscripts for the production of two UNESCO publications – a monograph on Scientific and Technological Literacy Within Formal Schooling, and a resource kit on Teaching Materials for Scientific and Technological Literacy. ICASE is

ICASE display stand at the 1998 ASE Annual Meeting, University of Liverpool, UK.
very appreciative of the substantial work that has been undertaken by its Executive Secretary, Jack Holbrook, in relation to these publications.

In 1996, ICASE established its own site on the World Wide Web. In addition to providing contact details for ICASE officers and member organisations, and information about ICASE and its programs, the website provides a place to publish resources for science educators. Web-based publishing provides a much less expensive alternative to print-based publishing, and it is likely that ICASE will use this medium more and more to provide access to publications and resources on-line. The website can be located at <http://sunsite.anu.edu.au/icase>.

Anna Garner, President-Elect, completed an entire revision of the ICASE Guidebook for Science Teacher Associations. This resource provides a most useful framework to assist in the formation of new science teacher associations or in the review and restructure of existing associations.

One of the pleasing developments already mentioned is the increasing activity of ICASE in leading workshops to develop curriculum materials consistent with the goals of Project 2000+. One of the key strategies in such workshops has been to involve practising teachers and, where possible, officers of the local science teachers association. This type of activity has served to enhance the skills of teachers and officers of science teachers associations and to encourage curriculum development agencies to involve practising teachers and local science teachers associations.

On the occasion of the 1997 ICASE Latin American Symposium held in Mar del Plata, Argentina, a Spanish Edition of the ICASE Journal was produced. A 1998 Spanish Edition is currently being prepared. This initiative is a particularly important one for ICASE to maintain and further develop. It recognises the necessity for an international organisation to operate beyond the English speaking context.

ICASE has been successful in extending its outreach directly to students through the 1995 ICASE World Activity Day coordinated by Bob Lepischak, Past President, and the regional representatives. ICASE has cooperated with the ASE in establishing the 1999 School Science Links Year in which schools in different countries link to work on common projects. Anna Garner, President-Elect, and the regional representatives have helped to set up this program.

**Human resources**

As already mentioned, ICASE continues to rely on the strength of its major resource – the willingness of individuals to commit their time and skills in order to further the work of ICASE.

ICASE continued to recognise special contributions to international science education through the ICASE Awards Program. The 1994 ICASE Distinguished Service Award was presented to Professor Dr Hans Jurgen Schmidt of the University of Dortmund, Germany during the German Science Teachers Association (MNU) annual meeting in Nuremberg in April 1995. The 1996 ICASE Distinguished Service Award was presented to Dr Robert E. Yager at the opening of the "Globalisation of Science Education" Conference, Seoul, Republic of Korea, May 1997.

In addition to past and present members of the ICASE Executive Committee and ICASE Award Winners, it has been especially encouraging to learn of a growing number of individuals, many of whom are very experienced in conducting international projects, who are expressing interest in contributing to the work of ICASE. I certainly hope that ICASE will be able to tap such offers of assistance and to coordinate projects in such a way so as to involve many more individuals outside of the Executive team.

One proposal, which the new Executive will be considering, is to establish an international consultancy group, comprising experienced science educators and researchers who could be involved in a range of educational consultancy projects (both small and large). It is proposed that the international consultancy group is registered with educational agencies around the world and that for its role in managing this group, ICASE receive administration fees.

I am particularly encouraged by the enthusiasm in Latin America to develop a strong ICASE program in that region following the very successful ICASE Latin American Symposium in Mar del Plata, Argentina. I am confident that this will be a major growth area for ICASE in the coming years and will bring additional talent to work towards ICASE goals.

**In conclusion**

As we look to 1998 and beyond, the challenges include:

- Developing mechanisms to provide more
direct, practical support to initiatives within ICASE regions, particularly the African region and the Pacific region

- Continuing to develop partnership programs with large associations, several of whom have very successful international programs within their own organisations

- Expanding ICASE services beyond the English speaking world into regions where French, Spanish and other languages are the major means of communication

- Continuing to provide a leadership and advocacy role for educational reform which seeks to develop scientific and technological literacy for all

- Finding ways to better mobilise the expertise and resources of ICASE members (including institutions of informal learning) in order to increase the effectiveness of ICASE programs

- Increasing the revenue base of ICASE and finding alternative, more cost-effective means to provide services for members

- Establishing a permanent secretariat for ICASE

My sincere thanks to those who have made space in their busy lives in order to support the work of ICASE. Both those within and outside the organisation acknowledge the herculean contributions that Jack Holbrook, Executive Secretary and Dennis Chisman, Honorary Treasurer have continued to make to ICASE during this term of office. Their work has been well supported and complemented by the other officers – Anna Garner as President-Elect, Bob Lepischak as Immediate Past President, Ron Bonnstetter as Journal Editor, Sue Dale Tunnicliffe as Primary Science and Technology Officer, John Penick as Special Projects Officer, Maris Silis as Policy and Development Officer and Claude Gadbois as French/Spanish Liaison Officer. The work of the regional representatives is worthy of special mention – these officers are the key people who provide an ICASE presence throughout the major regions of the world. My special thanks, therefore, to Isaiah Ikobi (Africa), Janchai Yingprayoon (Asia), Alicja Wojtyna-Jodko (Europe), Jose Chamizo (Latin America/Caribbean), Kenneth Roy (North America) and John Anderton (Australasia-Pacific). I know that there have been many others who have supported these officers – too numerous to acknowledge here. This team effort has made the last four years a most exciting period of development for ICASE and for me personally – thank you to each one.

While several officers have indicated that they are not standing for a position on the new Executive Committee, I would like to take this opportunity to mention one of these – Dennis Chisman. I single out Dennis because his involvement with ICASE spans a longer period of dedication and service than any other; in fact, Dennis Chisman has been a key figure in ICASE since its very inception. Many have aptly dubbed him as the ‘Father of ICASE’. It is a daunting prospect to consider an ICASE organisation without Dennis Chisman being involved. I am hopeful that, although Dennis will retire from the key roles he has held for 24 years with ICASE, he will find room in his very full life to support one or two projects and thereby continue to participate. On behalf of ICASE and its officers – past and present – I express our sincere appreciation and respect for the remarkable contributions that Dennis Chisman has made in building and shaping what today is a mature, diverse, active, effective and highly respected organisation.
SCHOOL LINKS INTERNATIONAL 1999
Celebration of School Science

Join hands across the world by sharing your science with a school from a different culture. Simply work on a similar theme and tell each other what you learn. Then join in our ‘Celebration of School Science’ by telling us about it. We'll help with contacts and ideas. So don’t be left out!

All participants will receive certificates. The best group will be part of an international ceremony.

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Obituary

ICASE is saddened to learn of the death of Dietrich Blandow. The worldwide profession involved with education about technology, taken in its broadest sense, has unexpectedly lost one of its pivotal international colleagues. On March 2, 1998, Professor Dietrich Blandow died peacefully in the presence of close colleagues in Erfurt, Germany. Dietrich Blandow will be remembered for his scholarship and many professional contributions as well as for his hallmark personal characteristics of energy, dedication, mentorship, friendship and caring. Most recently we remember Professor Blandow’s outstanding and influential international presence championing technology education. The ideas in his many publications, including edited books and a multitude of articles and presentations represent an ongoing contribution to technology that we can build on for years to come. Strategic vision, systematic analysis and creative configuration of innovative solutions are hallmarks that cut across most of Dietrich Blandow’s major achievements. It may be that this is best exemplified by his founding of the World Council of Associations for Technology Education (WOCATE), in consort with colleagues from Australia, the USA, and Greece, and his subsequent nurturing of it to NGO status with UNESCO.
The primary school curriculum: policies of environmental education in Bangladesh

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Curriculum development is a continuous process in any education system. So in a young country like Bangladesh, where education was neglected in the past, efforts have been made following its independence from Pakistan to alter the curriculum and syllabuses. These changes have been and are being made to have them harmonise with national goals and aspirations as well as changing needs and education. In the past, though some aspects of environmental education have been accommodated within the formal curriculum, there was little or no attention given to conservation skills. Neither was concern accorded to environmental awareness or to an appreciation of the total environment. Thus the acquisition of knowledge, skills and attitudes able to conserve and enhance the quality of the environment were neglected. The overall position was accordingly seen as unsatisfactory and an opportunity to develop a spirit of enquiry regarding appropriate forms of environmental education was sought.

Though the term environmental education was introduced during the mid 1960s, the ideas of environmental education matured internationally only after the Tbilisi Conference in 1977 (SEEC 1990).

The need for environmental education at all levels of education furthermore was stressed in the "International Strategy for Action in the Field of Environmental Education and Training" held in Moscow in 1987. So far, however, the actions of the International Program have mostly focused on incorporating environmental education in the formal education systems of UNESCO’s Member States (OECD 1993).

Thus, an urgent need was felt to incorporate environmental education topics at various levels of school education.

As a result, in 1975, the National Curriculum and Syllabus Committee (NCSC) was constituted to develop curricula and syllabuses up to pre university level of education. It followed that environmental education was accommodated in the formal education system up to junior level in 1977.

In Bangladesh one of the broad objectives of environmental education is to help children understand the environment, adapt constructively to it and contribute to its survival and development. Every child will be able to live in harmony with nature by understanding how it works. In pursuit of this goal, environmental education was introduced in schools from primary to junior level.

The curriculum and syllabi prepared by the National Curriculum and Syllabus Committee (NCSC) for primary (Grades I-V) and junior secondary (Grades IX-X) levels were introduced phase by phase between the years 1978 and 1983.

The primary curriculum included for the first time environmental education subject matter under the name of Environmental Studies which is interdisciplinary in nature. In this subject the elements of both natural and social sciences have been incorporated in such an integrated manner as the learners are exposed to their immediate environment from the very beginning of their life.
The principal aims and objectives of environmental education at primary level are, in short, as follows:

- to make the child aware of his environment in a simple manner and his position in it;
- to arouse interest in pupils towards all living and non-living objects around him;
- to develop skills for understanding and learning about the environment through scientific enquiry;
- to develop the competency of using the environment with a sense of balance and proportion;
- to develop social behaviour and discipline;
- to develop and foster a sense of patriotism, fellow-feeling and universal brotherhood;
- to include in him moral and spiritual values and develop an aesthetic sense;
- to promote physical development and help from the habit of healthy living;
- to develop a willingness to work individually and in groups and to form a positive attitude towards manual labour;
- to create a consciousness for maintaining and protecting the environment;
- to foster and develop a positive attitude towards the environment.” (Ali 1990)

Children at primary level are generally curious, imaginative and creative by nature. So the principal aims and objectives of Environmental Studies at this level are to help the young children to increase their power of observing things, expressing experience, taking decisions and thereby developing a positive attitude toward nature and society. Children will be able to understand their immediate environment by using natural elements and objects within the environment. On a small scale, they will observe their environment from which they will be enabled to solve problems related to the environment which they face in their everyday life. In the classroom they will participate actively, arousing their curiosity and leading to them enquiring about their environment. In order to attain all these objectives and to develop in young children skills and attitudes towards the environment, Environmental Studies has been introduced at primary school level.

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Science Across the World remakes its website

A working example of how the Internet can bridge language and cultural differences has been given a facelift after two years in the field and a rising popularity among schoolchildren in 46 countries.

The Science Across the World programme, coordinated by the Association for Science Education in Britain, was one of the first to incorporate a website into an education programme. The programme aims to raise awareness of science and technology issues in society, industry and the environment. The Internet was used initially to allow teachers and students to send information to other schools.

But there is much more to the new site. It is easier to navigate and more visually appealing. Ease of navigation and speed of download are key features. There are no spinning logos: instead there are resource areas, with discussion forums and news sections to contribute to. Nor is it all dull text. Video clips are available. And the whole thing is available in six languages - English, French, German, Italian, Portuguese and Spanish.

Those who dream of using the Internet in schools might like to check how its done in Science Across the World. There are 1 200 schools world-wide using the BP-sponsored programme, and in the last six years it embraces schools in Africa, the Asia-Pacific region, Europe and North and South America.

http://www.bp.com/saw
Encouraging the use of practical work in primary schools

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When primary teachers in The Gambia were asked why little or no practical work was carried out in primary science lessons three standard reasons were regularly offered in all earnestness. The first and most common was that they had no equipment, the second was that there was not enough time and the third that the classes were too big. Whilst the third does sometimes present some daunting challenges it is suggested that the real reasons for so little practical work were not quite as simple as those stated.

Availability of equipment

It is certainly true that the majority of the primary schools in The Gambia, especially in rural areas, have no standard equipment designated for science practical work. But, with the exception of perhaps magnets, no formal equipment is required before teachers are able to carry out a whole range of activities with their classes. At the same time these would cover most of the topics required in the syllabus. There are many opportunities for improvisation from materials in any of the local environments. What was lacking was recognition of the need to do practical work, the stimulus for ideas for improvisation and a background of experience of such activities on which to draw. Access to large quantities of materials might present a problem at times. However, with limited equipment a demonstration, well handled, would be better than no activity at all and sometimes this may be the appropriate teaching strategy.

Improvisation

Setting aside the lack of recognition of the importance of practical work for the moment, those teachers who have a good foundation of theory need some stimulus to get them started. It was found that once teachers were presented with some activities at a workshop, using local materials, and experienced using them, then they began to have their own ideas about other local materials which might be an alternative or even better for a particular purpose. At the beginning of the first term a week’s workshop was run for a group of teachers with this as a major theme. At the end of term when the teachers returned for further in-service training they all brought examples of improvisation. Many of the teachers had used an excellent variety of materials and showed considerable imagination. Both natural and man-made products had been pressed into service. One teacher proudly announced that he had had a much better idea than the original for making a model of pulleys and levers using common tomato paste tins rather than card from a box of tea.

Application

However, even when stimulated the teachers do have to have an idea of the ultimate purpose of an activity and an idea of how this may be achieved. This means a reasonable understanding of the concepts and principles behind the topics being taught. When asked if anyone knew how to show pupils a spectrum without using a prism one teacher demonstrated how he used a mirror and a dish of water (much simpler than the example in the book) but he couldn’t actually explain what was happening. He had achieved the result by observation and trial and error but at other times this may be an inhibiting factor to improvisation. It was therefore necessary to go...
through as much of the syllabus as possible carrying 
out the recommended activities (however simple) and 
suggesting others and discussing materials, theory 
and the relevant teaching points. Four separate weeks 
were used to cover, among other things, the topics of 
water, air, soil, and matter and energy (including 
light, heat, sound, electricity and magnetism). It was 
said that discussion on teaching plants and animals 
was not so necessary, though there was many a grade 
two lesson in a classroom surrounded by bush where the ‘parts of a plant’ were studied by means of a 
drawing of a hypothetical plant on the blackboard! 
After due consideration the teachers agreed that lack of 
materials was not the fundamental problem.

Use of Time

It cannot be denied that practical work takes time. 
Teachers frequently state that there just isn’t time to 
do activities. By this they usually mean that there is 
not time in class. There is the perception that 
activities are peripheral to the real job of learning. 
The syllabuses in many African countries, including 
The Gambia, are certainly entirely content based. 
Pupils must learn all the facts and spew them out in 
the exam.

Firstly, teachers had to be persuaded that doing 
practical work leads to greater understanding and 
hones learning, both of which are beneficial to the pupil 
in the short and the longer term. Secondly, the 
teachers’ time management needed to be significantly 
improved. Teachers had to be encouraged to be 
punctual, well prepared and have the class ready as 
simple starting points to managing time. Thereafter 
the need for good planning and management of the 
activity was stressed as being critical alongside a 
well trained class.

This naturally led to discussion of the problems of 
planning and preparation. Undoubtedly these take 
some of the teacher’s non teaching time and 
disincentives abound. In many cases there was very 
little motivation as a result of poor school leadership, 
lack of recognition of teachers’ efforts, conservative 
attitudes of the administration, other responsibilities, 
delay in payment of salaries and low salaries. In 
addition some teachers failed to accept the principle 
that they were primarily there for the benefit of the 
children. Several of these were government matters 
but others had to be tackled at the more local level of 
the region and the school. Time itself was not the 
problem.

Class size

In many situations the class size is an inhibiting 
factor especially in the lower grades of primary. 
Classes of 60 to 100 or more need special handling 
but the use of group work, for example, may still be 
achieved. In many cases, however, it is not the size 
itself but lack of teaching experience, concerns about 
discipline and class control, the organisation and 
planning of activities, noise levels and the perception 
of others that real work is not being done that inhibits 
the teachers. It is a fact that, despite legislation 
against it, the stick or plastic tube rink is still the main 
means of establishing and maintaining discipline in 
many primary classrooms. It is feared that once the 
situation of the teacher at the front with his or her 
stick of office to hand and the pupils in ranks facing 
the front (albeit squashed onto benches or mats on 
the floor), is broken then all discipline will be lost. 
Managing pupils in groups, talking, moving around, 
using water or soil or candles etc. presents a far 
greater challenge to the teacher. But this was thought 
to be so whatever the size of the class.

Lack of Confidence

To return to the question of recognition of the 
importance of practical work mentioned in the 
beginning. It is suggested that it is in fact lack of 
confidence which, though not stated, plays a major 
part in the reluctance of teachers to engage in science 
activities in primary schools. By this is meant lack of 
confidence in:

i. the importance and efficacy of practical work, 

ii the individual’s ability to carry it out in his or her 
classroom.

The importance and efficacy of practical work

Many of the teachers in The Gambia had studied at 
school, passed their exams and got where they were 
without the benefit of the practical work under 
consideration. They had, however, read and written 
about the various activities and could often quote 
examples for examinations. A major task was to 
induce confidence in the importance and efficacy of 
doing practical work at all. The most convincing way 
to do this was for the teachers to experience some of 
the activities for themselves. (A group of science 
teachers training to be tutors in Primary Colleges in 
Uganda were asked the one most significant occasion 
when they had learnt something in science. All but
one quoted an activity or experiment in which they had participated that had made all the difference to their understanding. The exception quoted the lesson where the teacher explained the 'mirage' effect on the hot tarmac road outside. Where opportunities for teachers to participate in and be encouraged to carry out activities existed then confidence in the importance of those activities soon grew. Too many instances occurred during workshops, where a teacher's face lit up as theory was shown in practice or teachers became totally absorbed in following an activity through, for this to be disputable.

The majority of teachers themselves were thus convinced. It was a short step to persuade them that such pupil centred teaching had value. Following this, as part of the course, the teachers were required to try out practical work with their classes. This led naturally to the second aspect. There still remained the need to persuade the teachers to 'risk' doing activities in class.

The individual's ability to carry out activities in his or her classroom.
Several obstacles stood in the way.

i. the lack of basic scientific knowledge of the teacher;

ii. the teacher's poor professional competence;

iii. concern over discipline;

iv. perceptions of hierarchy in the classroom; and

v. concern for the marginally higher noise level, likely fluidity of class structure and resultant possible censure from the senior staff.

Scientific knowledge and professional competence (i) & (ii) varied with individual teachers and were sadly weak in many cases. However, a start could be made through the in-service workshops. Besides going through the syllabus much emphasis, as might be expected, was put on planning, preparation and good classroom organisation. It was also decided that the teachers should be provided with user-friendly activity sheets, showing experiments and activities by means of very simple drawings with the text reduced to a minimum (7 or 8 words). Further basic information and hints for management were to be found on the back. In many cases these sheets were pictorial representations of activities mentioned in the text of the teachers' guides but which were often not read and rarely carried out.

A major concern was that of maintaining discipline (iii). Many teachers had few ideas as to the variety of ways in which discipline could be maintained and they needed help and encouragement to take any risk. The perceptions of hierarchy in the classroom (iv) presented an associated problem. The teachers strongly believed that they should know all the answers and always be right. This is a view shared by most of the pupils. Any weakness in these areas would result in loss of respect and loss of discipline. Rigidly controlled chalk and talk lessons would avoid most challenges, whereas activity based lessons could present teachers with unexpected situations and unpredictable questions thus possibly exposing them as less than omniscient. Changing these attitudes will be a long term operation but an effort was made to begin the process.

Finally, should the teacher be prepared to accept the slightly higher noise level resulting from pupil discussion and the greater activity in the classroom, there was concern about and experience of censure from the Head and senior teachers (v). It was found that it was essential that the head teachers be kept informed of what was being expected of the teachers by way of changing methodology and that they be encouraged to support it.

Conclusions

Whilst provision of equipment, time management and class size all represent obstacles to teachers doing practical activities they were in many cases a screen hiding the underlying lack of confidence of many of the teachers. Tackling the reasons for this was something that the teachers could not do by themselves. In-service courses and subsequent follow up and support were a means by which the teachers of the Gambia were helped and are continuing to be helped first by expatriates and now by Gambians. Those who benefited from training were expected in turn to help their school colleagues. It is to be hoped that the pre-service training will also make every effort to continue to promote and foster the importance of child centred learning and practical science activity in primary classrooms thus complementing the in-service work.

The Gambia is a small country with a relatively small population. The task in other parts of Africa is far greater and no less important, as many of the features discussed here are common to other African countries.
Left
Jan Vaernewijck (VELEWE, Belgium) with Hans-Jurgen Schmidt (MNU, Germany) in front of the Lithuanian Chemistry Teachers Association display at the ICASE General Assembly

Right
Joseph Depireux (GIREP, Belgium) and Alicia Wojtyna-Jodko (SNIPPIT, Poland) enjoying the displays at the ICASE General Assembly

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Nominations for this award must be forwarded by member organisations of ICASE. For full details of how to forward nominations, contact:
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ICASE Secretariat, PO Box 6138, Limassol, Cyprus
Email: icase@logos.cy.net
The teacher’s role in inquiry-centered experiences

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Introduction

It started with a simple laser beam on the ceiling. The lesson objective of teaching was: that the angle of incidence is equal to the angle of reflection. Once the kids illuminated the invisible beam bouncing off the mirror with chalk dust, they were snagged. From that moment, they began to develop their own question. They soon became fascinated by the discovery that by manipulating the laser, they could then manipulate the angle. Students became empowered by their own curiosity. As they began to develop their own questions, they started creating obtuse, acute, and right angles. They took the lesson to a different ‘plane’ by predicting if they used mirrors to become part of the beam, where would they line themselves up? The real investigations started, and it became real inquiry when the students took ownership of the investigation and started asking, ‘what would happen if …?’

The way students develop an understanding of a topic is by interacting with the content. Students’ interactions are part of the total learning process. Those skills that allow teachers to be good leaders of inquiry are the same skills used by the students. Teachers need to become responsive to how children learn. They must then give students permission to take ownership of the lesson once they are engaged. Often, teachers feel uncomfortable when the student comes up with a different answer from the one that teachers thought they would choose. This can be a moment when the teacher has to “let go” and then become the true ‘guide by the side.’

Over the past decade, the groundwork has been laid for new classroom approaches that encourage students to become active learners. It is imperative that we help all students learn to employ higher-order thinking skills. Higher-order thinking is defined by Lauren Resnick as nonalgorithmic: complex; amenable to multiple solutions; involving nuance judgment; which can employ multiple criteria for constructing meaning (Resnick 1989, 3). In contrast to previous theory, current views about learning and teaching emphasize “that higher-order skills must suffuse the school program from kindergarten on and in every subject matter” (Resnick 1987, 3). These higher-order thinking skills encourage children to become effective readers and to develop their mathematical skills, both of which are important for learning science.

The previously dominant view of instruction as direct transfer of knowledge from teacher to student does not fit the current perspective. The present view of learning places the learner’s constructive mental activity at the heart of all instructional exchange. This view does not mean that the student is left to discover everything for themselves, nor that what they discover and how they choose to describe and account for it are left solely to them. Instruction must provide experiences and information from which learners build new knowledge. Instruction helps to focus those processes so that the resulting knowledge is both valid and powerful.

The laser activity represents “content selected to meet the interests, knowledge, understandings, abilities, and experience of students” from the National Science Education Standards (NSES, 1996, Teaching Standard A, 30). Also included in this activity are the NSES Teaching Standards B: Teachers of science guide and facilitate learning. In doing this teachers:

• focus and support inquiries which interacting with students;
• orchestrate discourse among students about scientific ideas;
• challenge students to accept and share responsibility for their own learning;
• recognize and respond to student diversity and encourage all students to participate fully in science learning; and
• encourage and model the skills of scientific inquiry, as well as the curiosity, openness to new ideas and data, and skepticism that characterize science. (NSES, 1996, Teaching Standard B, 31)
What are the characteristics of a teacher who is using an inquiry instructional approach?

These characteristics of inquiry-based teachers should apply to all classrooms, not just to those teaching science. You would see teachers as the following:

- encouraging and accepting students’ autonomy and initiative;
- using raw data and primary sources, along with manipulative, interactive, and physical materials;
- when they are framing tasks, using cognitive terminology such as classify, analyze, predict, and create;
- allowing student responses to drive lessons, shift instructional strategies and alter content;
- familiarizing themselves with students’ understandings of concepts before sharing their own understanding of those concepts;
- encouraging students to engage in dialogue, both with the teacher and with one another;
- encouraging student inquiry by posing thoughtful, open-ended questions and asking students to question each other;
- seeking elaboration of students’ initial responses;
- engaging students in experiences that pose contradictions to their initial hypotheses and then encouraging discussion;
- allowing time after posing questions;
- providing time for students to construct relationships and create metaphors; and
- nurturing students’ natural curiosity. (Brooks & Brooks 1993, 102-18)

What is the teacher’s role in inquiry-based instruction?

In inquiry-based, student-driven investigations, teachers direct only a part of the action. In ‘real’ science, there is no absolute authority to supply an answer that scientists can’t find for themselves. No absolute authority can lend a hand by hinting to scientists that their investigation is on the right track or reassuring them at the conclusion of their efforts by confirming or rejecting the results. The students’ progress is enhanced if the teacher doesn’t give them the answer or even tell them in detail how to get the answers. This is an intrinsic part of modelling the process of doing science.

Teachers enter the teaching profession because they have a desire to communicate knowledge. The temptation to supply the answer is sometimes very strong. For a teacher to stand there and be only a ‘guide by the side’ while watching a student make an obvious mistake is very hard to do. It is the teacher who preserves through this period of time that reaps the rewards of their silence. The students find it is OK to make mistakes. The bodies of knowledge they construct in making the mistake is the important product of the investigation.

Teachers in an inquiry-based lesson must act as facilitators and resources. They are to create the environment which is safe for the investigations to take place; they impart conceptual knowledge, mathematical and technical tools, and general guidelines at optimal moments. Teachers are to select learning experiences and adapt and design the curricula to meet the interests, knowledge, abilities, and backgrounds of their students.

If teachers find that their students have little or no experience with experimental approaches, they may then begin with nothing more than a simple question. For example, “How can you make the laser beam bend?” would be a good question to begin with on the lesson using the laser. As the students become more sophisticated in their discovery, you could then pose the question, “How many ways could you come up with to make the laser beam bend around the entire classroom?”

While teams of students are working on the problems, the teacher is available to provide resources and responses to calls for clarification. Students, working together as a community of learners, are able to build and reflect on one another’s ideas. They will demand evidence from their peers, challenge the facts and pose other points of view (Jones and Fennimore 1990, 17). After the investigations are complete, the teacher will be there to moderate the discussion as groups of students share and critique each other’s findings. The teacher can then help the students make connections between their experiments and their knowledge of scientific concepts.

This all sounds very simple. But it is not. The teacher must learn to give up much of the initiation of action during the day. Teachers must surrender some degree of control over the class’s activities. Close attention is then paid to the quality and depth of students’ learning, and the assessment of the students’ progress can be time-consuming and difficult. Both the teacher and the student will need to participate in the ongoing assessment of student performance.
The biggest reward for the teacher when they choose to become facilitators of their students’ learning is seeing their students develop as independent learners. The students themselves will also feel this satisfaction. They will learn to believe in what they are doing as well as take the responsibility for constructing their own learning. Most of all they will be acquiring the skills necessary to make them independent thinkers.

**What are the limits on the freedom to explore?**

The challenge for teachers is deciding how much freedom to give their students to explore. The students need to spend some time exploring the topic and posing questions, but soon they must decide when to focus on their investigations. Teachers must provide as much guidance as necessary to ensure that all students acquire the expected knowledge, skills, and understandings.

Among the principal reasons for maintaining some structure in the classroom is ensuring that the significant scientific concepts are introduced. Those concepts are clearly delineated in the NSES document. The lesson using the laser was designed to teach concepts about light and the angle of incidence is equal to the angle of reflection. The true inquiry came when the students began to pose their own questions and structure their own investigations. Once the students have been introduced to the inquiry mode and experimental design they can easily take ownership of the investigation. Although the teacher has surrendered some control over the classroom, they are still there to focus the students back to the desired learning outcomes of the lesson.

Teachers also recognize early on that they will not cover as many topics as some of their colleagues. But they are committed to ‘less is more’ to ensure that their students thoroughly know, understand, and are able to do that science to which they are introduced.

**Teachers talking to teachers**

If the teacher is to develop an inquiry approach to their teaching methods they must take a fresh look at the materials and resources available to them. Familiar instructional materials such as textbooks, written problem sets, and reference books cannot be relied on to provide the needed material for their investigations.

Developing materials for student investigations is not an easy task. Many teachers gather materials via creative collaboration with their colleagues. By using the Internet, many teachers find themselves able to develop lessons from material taken from the World Wide Web sites and then turn around and share these lessons with others via the Internet. The beauty of this lies in the fact that teachers are able to take another teacher’s lesson and adapt to their own learning environment. This method of sharing is becoming one of the fastest growing means teachers have to bring innovative ideas and experiences into their classrooms.

**Assessment in an inquiry-centered classroom**

One of the biggest concerns from administrators and parents, and the most difficult to maintain, is the types of assessment necessary to demonstrate that learning has taken place in an inquiry-centered classroom. Teachers have to be responsible for continuous assessment strategies in their classroom. This requires the employment of an array of methods. These can involve asking the students to:

- generate rather than choose a response;
- actively accomplish complex and significant tasks; and
- solve realistic or authentic problems.

Such achievement in classrooms is assessed through:

- exhibitions;
- investigations;
- demonstrations;
- written or oral responses;
- journals; and
- portfolios.

Elements of this approach to assessment can easily be identified in the NSES. “Making assessment decisions through meaningful, complex tasks embedded in instructional activities” is an ongoing responsibility of the teacher (NSES, Assessment Standard D 1996, 84). Assessment is not a separate activity.

An inquiry-based curriculum does not isolate skills and facts. Rather, it emphasizes both through meaningful, complex tasks embedded in increasingly challenging environments. Materials and content are structured so that students gradually regulate their own learning. This approach ensures learning competence and confidence. Self-assessment of progress by both the individual students and groups is a very powerful result of an inquiry-based approach to learning science.
The National Science Education Standards contains the road map for exemplary science teaching and learning. Master teachers recognize inquiry as one of the many instructional strategies encouraged by the NSES. In order to meet the needs of students, teachers must feel confident in their abilities to recognize and implement different pedagogical approaches.

Inquiry extends beyond merely teaching the processes of science. The new vision on inquiry requires the student to combine processes and scientific knowledge as they use scientific reasoning and critical thinking to develop their understanding of the natural world.

The path that the teacher travels to become skilled at using inquiry in their classroom is not an easy one. If we were to make an analogy it could be learning to drive a car. When you are a beginning driver, driving looks like the most wonderful skill you could ever acquire. The first time you sit behind a wheel, however, you find out driving may not be as easy as it looked from the passenger seat. As the driver, you have to control the car, evaluate road conditions, estimate distances etc. After a few months of driving, performing all these tasks simultaneously begins to feel very natural.

Like learning to drive, all teachers learn to lead the inquiry-based science lessons by developing questioning techniques and management skills, and by providing materials and resources to foster their students' learning. They also must develop the assessments that match this type of instructional approach. Like driving a car, when all the elements come together in an inquiry-based lesson, the teacher will have that moment of "Ah-ha!"

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National Committee on Science Education Standards and Assessment. National Research Council


Science, Mathematics and Technology Education and National Development Conference
Hanoi, Vietnam, 1997

A book reporting on this conference has been prepared by Darrell Fisher and Tony Rickards (eds). The book contains over fifty papers that were presented at the conference on recent research and practical implications in science, mathematics and technology education covering the following areas: research methods; teaching; equity; teacher education; learning; curriculum; learning environments; assessment and evaluation; education technology; history and philosophy of science.

For details on how to order copies of the book please contact: Tony Rickards, Doctoral Student & Research Assistant, Science and Mathematics Education Centre, Curtin University of Technology, GPO Box U1987, Perth, WA 6845, Australia
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24
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Supporting change of science and technology teacher preparation in the Asian region

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The paper has an Asian bias, as the ideas are drawn from discussions with science teachers and educators who were sent by Member States to participate in regional workshops organized by UNESCO Bangkok. The presentation starts with an overview of the situation in the region, emphasising the education reforms taking place as influenced not only by socio-economic developments more so by advances in science and technology. These reforms have implications on the preparation of science and technology (S&T) teachers. The paper points out the demands for the S&T teachers, the role they have to play, the competencies and skills required and the need for changes in the science and technology teacher preparation programs. The 'pointers and recommendations' of the Delors report are presented, as these are found to be relevant to the quality improvement of science and technology teaching and learning.

Overview of the situation in Asia

The education reforms undertaken by countries of Asia in order to prepare for the 21st century, are influenced by the socio-economic developments and the specific awareness of the need to cope with the challenges of change, brought about by the advances of science and technology in all aspects of political, social, moral and economic life of their people, among other reasons. The reforms in the educational structure include re-orienting, reshaping, 're-engineering' the curriculum, the professional development of teachers, school administrators and other school personnel, the evaluation and assessment strategies, the school supervision, administration and management, the strengthening of institutions, the conditions of work and other areas of education. Although science education always had a recognized place in the school education of the countries, shortfalls were recognized in the program, which needed reorientation. These shortfalls are the focus on specialised disciplines e.g. physical science, biological science, environmental science, etc, the emphasis to prepare students for higher education and to become specialists in specific areas and the absence of linking to technology and the world of work as well as the exclusion of ethics and social responsibility.

Conceptual changes have been attempted in the teaching of science. In 1983, the 'Science For All' program was initiated in the region. At that time, science education aimed to produce an appropriately equipped workforce and also aimed to produce citizens who would be comfortable with, and able to benefit from, science learning. Whilst acknowledging that the concept was relevant to lifelong learning, and trying out many strategies in science teaching such as
‘learning by doing’, ‘activity approach’, ‘inquiry approach’, ‘child-centred approach’ etc., which were attempts in the right direction and could be considered as the outcome of past experiences in science teaching, most students were turned away from science. It was because science teachers attempted to move their students into the world of science, especially in the world of the research scientists - which were noted to be far removed from the everyday world. But the blame should not be on the teachers, as they learned all these things during their preparatory work in science teaching. As it is said, “teachers teach the way they were taught”.

Aware of these shortfalls, UNESCO in partnership with UN agencies and other intergovernmental organizations and NGOs initiated Project 2000+: Scientific and Technological Literacy for All, which is aimed to revitalise and reform science and technology education at all levels. The project recalls the World Declaration on Education For All (Jomtien, 1990) which recognized that “sound and basic education is fundamental to the strengthening of higher levels of education and of scientific and technological literacy and capacity and thus to development of self-reliance”. The project further recalls the worldwide concern for the environment and for the quality of human life, put forward in Agenda 21 of the UN Conference on Environment and Development (Rio Summit, 1992). One area of reform demanded is on teacher preparation. Thus this paper discusses the needed change in the preparation of science and technology teachers.

The demands on science and technology teachers

The teacher as an agent of change plays a pivotal role in the teaching-learning process. It has been said that “no education system can rise too far beyond the level of the teachers in it” (Roy Singh, 1991). Though teachers are faced with lots of constraints - some of which are those related to handling large classes, meagre resources to manage; handling new inputs in the curriculum without adequate training, examinations, etc., they are expected to fulfil their tasks effectively, in transacting the teaching-learning process. The demands on teachers, especially on those teaching science and technology, are very high.

The tasks are enormous - to prepare the learners to face real-life situations, and not only for the examinations but for life; to be made alert about the changes taking place in the immediate environment, the scientific and technological developments, the social, cultural, and behavioural aspects of life; to acquire skills and competencies like making a point in a conversation, making adjustments, processing information, behaving properly in a group etc. There are also demands to enable the learner to react to situations with rationality and scientific temper; foresee the future environment, newer technologies and their impact, and identify such elements as are likely to contribute to it significantly.

With the tasks identified the science and technology teacher is expected to observe his or her own way of working, analysing his or her reactions so he or she could adjust her/his teaching approach, style, habits and even personality based on the background and behaviour of the learners and modify his/her teaching methodology or style accordingly; appreciate the necessity of not only teaching but also interacting and listening to the learners; mobilise resources and utilise these appropriately according to the needs of the teaching-learning process; evolve a teaching methodology to adapt to the changing situation, using appropriate language, update with new knowledge and information, upgrade with new skills and competencies, including assessing and evaluating the learner’s performance, in terms of relevance and quality of learning. These expectations can only be fulfilled by the teacher if she or he believes that there is more than transfer of knowledge as a professional obligation. Furthermore, the status of teachers also has to be improved.

The various roles of the science and technology teacher

The S&T teacher has to be provided with opportunities in order to be able to promote science and technology education and in performing various roles.

Curriculum developer
The S&T teacher gets involve in curriculum renovation, even in a highly centralised education system, to develop a curriculum which relates to real-life situations, design locally relevant activities, utilise local resources and encourage the learners to bring in to the classroom their life experiences. He or she designs and organizes in-school and out-of-school activities, mobilise community expertise to assist the school and improvise equipment whenever necessary.
Innovator and motivator of learning
The S&T teacher designs science activities and mobilises resources from the environment or makes use of low-cost or no-cost equipment. As motivator of learning, good examples are set, he/she makes learning rewarding and interesting, generates curiosity, explains natural phenomena, provokes learners to be more inquisitive and gets involved as an active partner in the learning process.

Life-long learner
The S&T teacher has to be a life-long learner, by continuously updating and upgrading himself or herself, with new knowledge and skills. He or she also learns from his/her pupils through interactions, questions and interventions in the learning process. The rapport of pupils with the teacher could also be converted into potential instruments of evaluating his or her own learning.

Community collaborator
The S&T teacher serves as a resource person for the community, as well as counsellor of parents regarding their children. To perform this role, the teacher has to understand the existing socio-economic and cultural scenario and the possible impact of scientific and technological changes in order to prepare the community to accept not only those changes which would provide short-term gains but also lasting benefits. A close working relationship with the school and the community has to be established which would mean mutual accountability. This relationship would contribute to the effective functioning of the school.

Evaluator
The S&T teacher requires an in-depth understanding and adequate preparedness of the objectives of evaluation, to prepare the learners for life, to evaluate their interest, attitudes, values and ability in decision-making, their manipulative, laboratory and life skills and their understanding and analysing of concepts.

The competencies and skills of the science and technology teacher
To meet the demands to perform the above roles, the S&T teacher would demand new skills and competencies. In Project 2000+ teachers need diverse teaching-learning experiences in order to develop concepts and skills that are flexible and applicable to a variety of situations. They should be exposed to opportunities to allow divergent thinking required to anticipate problems and identify strategies to find alternative solutions. The competencies and skills required are described as follows:

Process skills
The basic skills required to develop the learner’s scientific and technological capabilities include: observation, use of space-time relationships, classifying, using numbers, measuring, communicating, predicting and inferring. The integrated basic skills are needed for the development of higher-order skills such as information processing and utilisation, creativity, problem-solving and decision-making.

Information processing and utilisation
Information is growing so rapidly that it has become impossible for the teacher to be a ‘know-all’ individual. The competence of the S&T teacher in information processing and utilisation is necessary to identify and locate sources of information, establish necessary opportunities to procure these and then sort out and identify relevant and appropriate materials.

Creativity
Scientific and technological developments, reaching every member of society, provide ample scope for identifying creativity-oriented situations. All children are endowed with the inherent talent of creativity. S&T teachers, therefore, should take advantage of this gift by providing creativity-nurturing activities. Probing, analytical, open-ended questions would not only lead to solutions but also permit full scope for the learners to formulate alternative solutions confronting everyday life.

Managerial and entrepreneurial skills
More often, a primary and secondary school teacher works under constraints of lack of resources and teaching-learning materials. In many instances, there is also a lack of opportunity in updating his or her knowledge and upgrading his or her skills. But to a school child, the teacher is a fountainhead of knowledge, a role model and mobiliser of resources, thus the teacher has to be a good manager and entrepreneur.

Decision maker
Decision making requires accurate and adequate information. The science and technology teacher is expected to help the learner present information, possibilities and alternatives objectively to resolve issues affecting people’s quality of life.
The need for change in the S and T teacher preparation programs

The educational reforms in member countries have resulted in perceptible changes in the objectives, structures and contents of science and technology teacher preparation programs. The following objectives are being suggested:

- to develop a holistic understanding of the nature of science and technology;
- to acquire a sound scientific and technological literacy and appreciate the social and ethical aspects of science and technology;
- to analyse critically the science and technology curriculum in terms of content, activities and applications;
- to plan and organise suitable activities, and mobilise resources;
- to design, identify and implement teaching-learning strategies aimed at developing scientific and technological skills and competencies;
- to relate learning experiences and activities to the cognitive level of the learner;
- to design and organize activities to help children with special learning needs e.g. slow learners, physically and mentally handicapped, the gifted and the talented;
- to encourage learner-centred, activity-based, participatory, cooperative activities;
- to utilise learning experiences from real-life and the immediate environment of the learner, and which could be obtained by the teacher and learner working together;
- to develop suitable monitoring, assessment and evaluation strategies, and be attentive to feedback for remediation;
- to improvise, handle and utilise low-cost teaching-learning aids to make the learning experiences and environment interesting especially to the learner;
- to appreciate the use of educational technology and be able to use it in the teaching-learning process;
- to familiarise and get updated with educational changes taking place;
- to equip oneself to act as interpreter of new ideas and technologies for the benefit of the learners and the community members;
- to find the relationships of science and technology with health, agriculture, industry, environment, food and nutrition and other aspects of living;
- to use scientific knowledge in correcting misconceptions, false beliefs, prejudices and practices; and
- to develop decision-making skills and utilise these in real-life situations.

The changing times have enhanced the roles and responsibilities of science and technology teachers. It is therefore necessary that teacher training institutions take due cognisance of the changing scenario and provide a kind of science and technology education which must meet the new challenges. While pre-service training of teachers is very important, equally significant are the in-service programs which can really update the teacher, and keep him or her abreast of new developments, particularly in science and technology relevant to the community. The teacher has to be all the time ‘aware and alert’. Apart from formal training, the teacher’s interest, aptitudes and creative abilities would contribute to the efficiency and effectiveness of his or her teaching. He or she has to possess first of all rational and scientific thinking to make his or her teaching dynamic.

The responsibility for training of teachers does not only lie on what the government can offer. The community and society are equally responsible to meet the new challenges.

Recommendations

In the report of the International Commission for the 21st Century (Delors Report, 1996), the role of the teachers and the need to improve their training, status and conditions of work are stressed. The report has emphasised ‘learning throughout life’ as one of the keys to meeting the 21st century - based on four pillars of learning. These are: Learning to be, Learning to know, Learning to do, and Learning to live together - learning to live with others.
Based on the four pillars, ‘pointers and recommendations’ have been proposed, which are relevant to the quality of science and technology teachers. These are classified and summarised as follows:

- the psychological material situation;
  - vary from country to country,
  - upgrading of their status is essential if ‘learning throughout life’ is to fulfil a central function in the advancement of our societies and the strengthening of mutual understanding among peoples,
  - their position as master or mistress in the classroom should be recognized by society and they should be given the necessary authority and suitable resources.

- the concept of learning throughout life;
  - leads straight on to that of a learning society, a society that offers many and varied opportunities for learning, both at school and in economic, social and cultural life,
  - the need for more collaboration and partnerships with families, industry and business, voluntary associations, people active in cultural life, etc.

- teachers’ imperative requirement to update knowledge and skills;
  - their professional lives to accommodate the opportunity, or even the obligation, for them to become more proficient in their art and to benefit from periods of experience in various spheres of economic, social and cultural life;
  - to be provided with many forms of study leave or sabbatical leave.

- the teacher is faced with his or her own responsibilities and professional duties, but;
  - teamwork is essential, particularly at the secondary level, in order to improve the quality of education and adapt it more closely to the special characteristics of classes or groups of pupils.

- the importance of exchanges of teachers and partnerships between institutions in different countries;
  - such exchanges and partnerships provide an essential added value not only for the quality of education but also for a greater receptivity to other cultures, civilisations and experiences.

all these lines of emphasis to be a subject of dialogue, or even of contracts;
- with teachers’ organizations which go beyond the purely corporate nature of such forms of collaboration,
- over and above their aims of defending the moral and material interests of their members, teachers’ organizations have built up a fund of experience which they are willing to make available to policy-makers.

With these views put forward, we hope to receive support for the improvement of the science and technology teacher preparation programs in the region.

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Evaluation of clientele impact of science exhibits

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An impact evaluation model across time and clientele groups was used to evaluate exhibits of two Science Centres in Metro Manila. Immediate impact on majority of grade school to high school students, based on questionnaire and interview data, was great interest in science and science career choice. Short term and long term impact indicated lower student percentages. Student quiz performance was average. Experts highly rated exhibits’ alignment to national goals. Students preferred manipulative exhibits producing sound, light and motion.

Introduction

The Science Centres evaluated in this study are the Philippine Science Centrum and Science Works, both located in Metro Manila. The Centres were established by the Philippine Foundation for Science and Technology, a non-profit private organisation that aims to promote science and technology among the youth. Established in February 1990 with the support of the Department of Science and Technology, the Science Centrum is the first Science Museum in the country. It showcases nearly a hundred interactive exhibits in science and mathematics. Science Works is a satellite of the Centrum created in May 1993 particularly for children, ages three to twelve. The Centres aim to stimulate children’s curiosity and interest in science.

The evaluation sought to determine the attainment of the objectives of the Centres based on perceptions and observed behaviour of its clients – children (ages three to sixteen), teachers, principals and parents or adult companions of the child. It focussed on the influence of one or more visits to the Centres on the students’ science learning, interest in science, subsequent science-related activities and career choice. It also studied the students’ behaviour at the exhibits, their exhibit preferences and clients’ perceptions on admission cost. The study aimed, too, to identify characteristics of best-liked exhibits and describe trends in student clientele size and composition since the establishment of the Centres. Experts’ ratings of the exhibits’ alignment to national goals were also obtained.

Evaluation Framework

The impact evaluation model developed and used in the study (Fig. 1) shows impact across time and clientele groups. The model built on the short-term and long-term impact model used in a 1987 evaluation study of the Singapore Science Centre (Talisayon and Talisayon, 1987).

The clientele in focus in this study is the group of children from preschoolers to high school students. Perceptions of the other groups – parents or adult companions, teachers and principals were mostly in relation to exhibit impact on the students. Experts were also included as clients, because they rated the exhibits while viewing them. The experts’ ratings were based on national goals, specifically, the Science and Technology Agenda for National Development, Philippines 2000, of the Department of Science and Technology (Quiason and Quiason 1995).
Across time, the impact was categorised as immediate (during the visit – as the students interacted with the exhibits and as they left the Centre), short-term (within one or two years after the visit) and long-term (after two to four years from the visit). Measures of immediate impact were children’s behaviour at exhibit; their science learning, interest in science, exhibit preference and career choice immediately after exhibit viewing; and exhibits’ alignment to national goals. Short-term and long-term impact was measured in terms of science learning, interest in science, exhibit preference, career choice, perception on admission cost and performance of science-related tasks.

**Figure 1 Evaluation Framework of the Study**
Methodology

Evaluation design

Employed in the study is a five-stage impact evaluation design, as follows:

Stage 1 Identification of Impact Receivers and Environment

The impact receivers or clientele groups were identified (Fig. 1) with the children as the clientele in focus, based on the objectives of the Centres. Due to time constraints, Metro Manila was selected as the impact environment. Since the Centres are in Metro Manila, it is also the immediate impact environment.

Stage 2 Setting of Time Frame and Assessment Points

Three time frames and, consequently, three assessment points were chosen for immediate, short-term and long-term impact (Fig. 1). The years of existence of the Centres were considered.

Stage 3 Determination of Impact Measures Using Evaluation Models

The models used in this study were those relating to evaluation of attainment of objectives, inputs (e.g., student perception of interest in science prior to visit), processes (e.g., behaviour at exhibit) and outputs (e.g. short-term and long-term) and unexpected outcomes.

Stage 4 Simultaneous Data Collection

Due to time limitation in data collection, data were obtained simultaneously from visitors representing different time frames.

Stage 5 Quantitative and Qualitative Data Analysis

Trends were analysed and impact compared across time and student clientele groups. Frequencies, percentages and mean scores were qualitatively compared.

The Sample

The sample consisted of students and schools to which the research team had easy access in the allotted three month (August – October 1995) data gathering period. Involved in the study were 1445 students from 16 elementary schools (15 private schools, one public school) and 948 students from 12 high schools (9 private schools, 3 public schools) in Metro Manila.

Three science education experts from the Department of Science and Technology rated the alignment of exhibits with national goals in science and technology.

The Instruments

Table 1 shows the instruments developed and used by the research team for the students and experts. A total of fourteen instruments were constructed for different clientele groups for the two Centres for three time frames.

<table>
<thead>
<tr>
<th>Impact Measure</th>
<th>Instrument</th>
</tr>
</thead>
<tbody>
<tr>
<td>Behaviour at Exhibit</td>
<td>Exhibit Observation Form</td>
</tr>
<tr>
<td>Exhibit Alignment to National Goals</td>
<td>Exhibit Rating Scale</td>
</tr>
<tr>
<td>Science Learning</td>
<td>Science Quiz (3 versions)</td>
</tr>
<tr>
<td>Interest in Science</td>
<td></td>
</tr>
<tr>
<td>Immediate</td>
<td>Exit Questionnaire (4 versions)</td>
</tr>
<tr>
<td></td>
<td>Interview schedule</td>
</tr>
<tr>
<td>Short-term / long-term</td>
<td>School Questionnaire for Students (2 versions)</td>
</tr>
<tr>
<td>Exhibit preference</td>
<td>-do-</td>
</tr>
<tr>
<td>Career Choice</td>
<td>-do-</td>
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<tr>
<td>Percepcion on Admission Cost</td>
<td>-do-</td>
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<tr>
<td>Performance of Science-Related Tasks</td>
<td>School Questionnaire for Students</td>
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</table>

*Table 1. Some Instruments for Impact Measures*
The Exhibit Observation Form focussed on the condition of the exhibit, the number of visitors' verbal and non-verbal reactions to exhibits, including repeated viewing. The exit questionnaire (given at the Centres) had nine questions for grades 1 – 4 and eleven questions for grade 5 to high school students. The school questionnaire for students, administered in school by teachers, had fourteen questions each for grades 1 – 4 and grade 5 to high school. The questionnaire was administered orally to grades 1 – 3 pupils. The interview schedule (6 – 12 questions, depending on the respondent's age) and the school questionnaire for grade 5 to high school asked students to describe in sentences or pictures how the visit affected them.

Other instruments were the School Interview Schedule for Teachers (17 questions) and the School Interview Schedule for Principals (8 questions). The interview schedule was given at the Centre, mostly at the Science Works, to preschoolers, parents, teachers and other adult companions of children visitors. All questionnaires and interview schedules asked for suggestions to improve the Centres.

The written quiz consisted of ten items for grades 1 – 3, administered orally; fifteen items for grades 4 – 6; and 30 items for high school. These were based on the written explanation/description accompanying the exhibit. The reliability coefficients (Cronbach alpha) of the revised quizzes were 0.63 (grades 1 – 3, 60 students), 0.61 (grades 4 – 6, 180 students) and 0.56 (high school, 1st – 4th year, 100 students).

The instruments were pre-tested. The quizzes, questionnaires and interview schedules were tried out in a public elementary school and in two high schools, one private and the other public. Revisions were minor, like inserting Filipino translation for questions and using simpler words for lower grades.

The exhibit rating scale used by the experts was a five-point scale where '1' meant 'not at all aligned' and '5' represented 'perfectly aligned'. Rated were 90 exhibits of the Centrum and 50 exhibits of the Works.

To supplement the Exhibit Observation Form, behaviour at the Centrum exhibits of two groups of student visitors was also videotaped. For the trends in clientele profile across time, data were obtained from admission records.

Major Findings

The results given in this paper are limited to student data and experts' ratings.

Student Client Profile Trends

The number of visitors of Science Centrum increased at an average rate of 24% per year for 1990 – 1994, with the highest increase (46%) from 1991 to 1992 and lowest increase (8%) from 1993 to 1994. On the average, 70% of the visitors in 1990 – 1994 came from private schools, 59% from Metro Manila, about 50% were elementary school students, 46% were high school students and only 4% were preschool students.

In 1994 – 1995, 88% of Science Works visitors came from private schools and 85% from Metro Manila; 43% of the visitors were preschool students, 43% grade school students and only 14% high school students.

Career Choice

An immediate impact of the visit to the Centrum or Works was that the majority of grade school students (69%) and high school student (57%) replied that their visit made them want to be a scientist or engineer. The percentage decreased to 50% (grade school) and 35% (high school) within one to two years after the visit for another group of students. For a third group of students, the percentage slightly increased to 55% (grade school) and 42% (high school) two to four years after the visit.

Science Learning

More than 50% of the visitors from elementary to high school indicated that they learned 'very much' from the exhibits immediately after viewing them and 'much' one to four years after the visit. However, their performance in a written quiz on the science and mathematics concepts of the exhibits was average: 51% for Grades 1 – 3, 46% for Grades 4 – 6 and 44% for High School.

A high performance level in the quiz was not expected by the Centre management in view of the limited goal of stimulation of curiosity and interest in science among children. The Singapore Science Centre management held a similar view of the impact of a science museum on children (Talisayon and
Talisayon 1987). Besides, time spent in the centre per visitor was about an hour for 50 to 90 exhibits. Research on concept learning indicates that learning takes time. However, it is interesting to note that the majority of the students felt that they learned very much or much after the visit.

**Interest in Science.**

Majority of the student visitors expressed interest in visiting the Centrum or Works again. For those who just saw the exhibits, the percentages were 74% for grade school students and 66% for high school students. The percentages increased within one to four years after the visit to 86% for grade school students and 82% for high school students. For the same period, 89% of the grade school students and 96% of the high school students wanted their friends to visit the Centrum or Works.

Immediately after the visit, the experience increased the visitors' interest in science 'very much' for elementary school students (72%) and high school students (69%). The percentage for 'very much' decreased to 54% (grade school) and 49% (high school) within one to two years after the visit. Two to four years after the visit, the perceived increase in interest in science due to the visit was 'much' for 53% of elementary and high school students.

Immediately after viewing the exhibits, 77% of elementary and high school visitors found the exhibits interesting and 21% considered them useful. Another measure of interest in the exhibits was the number of students who talked to their family and friends about the exhibits after the visit – 88% of grade school students and 95% of high school students within one to four years after the visit to the Centrum.

**Alignment to National Goals**

On the extent to which all the exhibits – content, skills required and attitudinal impact – are aligned with the Science and Technology Agenda for National Development, Philippines 2000, the experts gave an average rating of ‘3.98’. The high mean rating was perhaps partly due to the involvement of the technical staff of the Department of Science and Technology in evaluating exhibit development proposals of the Centres for funding by the Department.

Exhibits receiving ‘5’, the perfect rating of alignment, included the phosphorescence, plasma sphere, laser, coloured shadows, Bernoulli blower and lego. These exhibits were also best liked by students.

**Exhibit Preference**

Based on behaviour at exhibits (e.g. biggest number of viewers, repeated manipulation, animated talk, smile or laugh), questionnaire and interview data, the best liked exhibits were those involving three or more senses. These exhibits were not only manipulative, they produced sound, light and motion. Such characteristics support the findings of an earlier museum evaluation study done by the author (1987).

**Admission Cost**

A great number of visitors (64%) thought that the admission cost – P20 (Us$1.00 is about P26) for the Centrum and P75 for the Works – was reasonable. For maximum entrance fees that student visitors were willing to pay, the amount receiving the greatest percent response were P20 (24%), P50 (19%) and P100 (12%).

**Visitors’ Suggestions**

Suggestions from different clientele groups included improvement of facilities and increasing the number of exhibits. One recommendation was to have the accompanying description or explanation of the exhibits also in Filipino besides in English. Some students suggested having exhibits in the Life Sciences.

**Conclusion**

The rated alignment of the exhibits to national goals is high. A continuing effort to increase the number of exhibits with perfect alignment rating is needed. These exhibits which involve as many senses as possible are also best liked by students.

The Centres attracted mainly students from the private schools in Metro Manila, elementary and high school students for the Centrum and preschool and grade school pupils for the Works. Admission fee may be a factor. There is a need for wider campaign for visits to the Centres among public schools in and out of Metro Manila, perhaps considering fee waiver or subsidy and locating private and public subsidy sponsors.
Majority of the student visitors expressed learning very much immediately after a visit to the Centre, although the performance in the quizzes was only average. The low reliability of the quizzes can be improved in a future study, for example, by increasing the number of questions. Longer exposure enriched by explanations of science concepts can be explored for best liked exhibits.

Science teachers and school administrators can consider the major finding that the immediate impact of the exhibits for majority of the grade school and high school student visitors is to make them want to be a scientist or engineer and to increase ‘very much’ their interest in science. That the percentages for a science career choice and high interest in science dropped within one to four years after the visit is worth noting. An unexpected outcome is that percentages in science career choice and interest in science at different time frames are higher for grade school students than those for high school students. Reasons for the differences can be studied.

How can the Centres’ immediate impact of students’ choice of a science career be maintained in the science classroom? How can science classes sustain, if not enhance, the students’ high level of interest in science immediately after a visit to a Centre? How can schools have the same joy and wonder of learning of learning science as in the Centres? These questions may be addressed by teachers and researchers alike. As an educator, Joseph Galdon, puts it “Learning begins in wonder, or it does not begin at all”.

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Contact: Caroline McGrath, The Science Centre, The Runnymede Centre, Chertsey Road, Addlestone, Surrey KT15 2EP, fax: +44 1932 570 161, email: <caroline@sci-ence.demon.co.uk>

June 3 - 5
Utrecht-ICASE International Symposium
Location: Utrecht University, Netherlands
Contact: Dr Onno de Jong, Chairman, Department of Chemical Education, Utrecht University, Princoenplein 5, 3584 CC Utrecht, Netherlands, fax: +31 3 0253 7494, email: <o.dejong@chem.ru.nl>
This conference follows on from the very successful series of symposia at Dortmund University, organised in association with ICASE. The theme will be 'Bridging the gap between theory and practice: what research says to the science teacher'.

July 5 - 10
CONASTA 47 Conference
Location: Northern Territory University, Northern Territory, Australia
Contact: Mr Stephen Zander, CONASTA 47 Secretariat, PO Box 778, Nightcliff, Northern Territory 0814, Australia, fax: +61 8 8999 6976, email: <conasta47@topend.com.au>
Science educators at primary, secondary and tertiary levels are invited to the 47th Annual Conference of the Australian Science Teachers Association, featuring keynote presentations, seminars and workshops on the theme 'Science Education: Beyond the Horizon'. See the conference website for further information: <http://www.topend.com.au/~stant/conasta.htm>

July 5 - 9
SCICON 98 Conference
Location: Nelson, New Zealand
Contact: SCICON Conference, PO Box 1254, Nelson, New Zealand, fax: +64 3 546 6020, email: <scicon@confer.co.nz>
Join science educators from across New Zealand and beyond for the 11th Biennial Conference of the New Zealand Association of Science Educators, NZASE. See the website for more information: <http://nzase.org.nz/scicon.htm>.

July 9 - 12
ASERA 98 Conference
Location: Casuarina Campus, Northern Territory University, Northern Territory, Australia
Contact: Mr Bill Palmer, ASERA 98 Conference Organiser, Faculty of Education, Northern Territory University, Darwin, Northern Territory 0909, Australia, fax: +61 8 8946 6151, email: <palmerew@darwin.ntu.edu.au>
The 29th Annual Conference of the Australasian Science Education Research Association will provide a forum for the discussion of science education research issues. See the conference website for further information: <http://www.ntu.edu.au/faculties/education/asera98/asera98.htm>.

July 14 - 18
Second China-US Conference on Education
Location: Beijing, China
Contact: Conference Secretariat, fax: +1 602 943 4458, email: <global@goodnet.com>
This conference focuses on four themes: Quality of personnel, Quality of students, Quality of parenting, Quality of curriculum.

July 25 - 28
NSTA-NCSA Summer Institute
Location: Northern Arizona University, Flagstaff, Arizona, USA
Contact: NSTA Conventions Department, 1840 Wilson Blvd, Arlington, VA 22201-3000, email: <conventions@nsta.org>
Join teacher leaders in examining the theme 'Making curricular connections in the K-8 classroom'. Topics for exploration include: multiple intelligences, standards-based practices, service learning, performance-based assessment, thematic instruction, project-based learning, planning and managing integration, issues-oriented learning, and literature connection. See the website for further information: <http://www.nsta.org>.
August 5 - 7
International Conference on Learning Science in Informal Contexts
Location: Questacon – The National Science and Technology Centre, Canberra, Australia
Contact: Kayt Watts, Conference Secretariat, PO Box 3182, Manuka ACT 2601, Australia, fax: +61 2 6239 7948, email: ingenue61@bigpond.com.au.
Organised by Questacon as part of its tenth birthday celebrations, in association with the Centre for Public Awareness of Science at the Australian National University, this conference will be the first of its kind in Australia. It will enable researchers and educators from science centres, museums, zoos, botanical gardens, wildlife parks, schools and tertiary institutions to share their views on learning science in response to the growing interest in the role that informal learning plays in increasing people’s understanding of science. See the conference website for further information: <http://sunsite.anu.edu.au/Questacon/conference.html>.

September 3 - 5
International Conference on Science and Technology Centres/Museums
Location: China Science and Technology Museum, Beijing, China
Contact: Mr Ou Jiancheng, International Conference Secretariat, China Science and Technology Museum, 1 Bei San Huan Zhong Road, Beijing 100029, China, fax: +86 10 6237 9378, email: <cstm@ihw.com.cn>.
This international conference is being organised in conjunction with the First Conference of the Asia Pacific Network of Science and Technology Centres and focuses on the theme of ‘Science and Technology Centres and Museums: Educating and Enlightening the People’. The conference will provide a forum for science and technology centre/museum professionals from across the world to share their ideas on how centres of non-formal and informal learning can promote scientific literacy for the general community. See the conference website for further information: <http://www.cicsst.org.cn/bicstcm’98>.

September 24 - 27
International Working Seminar of Scholars for Technology Education
Location: George Washington University, Washington DC, USA
Contact: Prof. Dr. Michael Dyrenfurth, President, National (USA) Association of Industrial and Technical Teacher Educators, 105 London Hall, Technology & Industry Education, University of Missouri-Columbia, Columbia, MO 65211, USA, fax: +1 573 884 4095, email: <pavtnike@showme.missouri.edu>.
The National Association of Industrial and Technical Teacher Educators, the European Society for Technology Education and the World Council of Associations for Technology Education invite you to participate in an international seminar on the theme ‘Outcomes of Technology Education for 2000+: A Focus on Learning: Models, Criteria and Demonstrations of Applied Learning and Assessment Methodologies’. The following themes present an opportunity for the seminar participants to structure their remarks: subject centered and/or interdisciplinary orientations for technology education; what are the key outcomes/benefits that result from participation in technology education; which learning and assessment theories are significant with respect to becoming competent in technology; what are the standards and models for technology teacher education; how can persons with special needs be better served and how can the diversity and inclusiveness of technology education be enhanced. See the website for further information: <http://unesco.uneb.edu/wocate>.

November 5 - 7
Annual Conference of the Science Teachers Association of Ontario
Location: Toronto
Contact: Jon P McGoey, c/o John Paul II Secondary, 1300 Oxford Street East, London, Ontario N5V4P7
email: jmcgoey@quark.physics.uwo.ca
Information is on the website at <www.stao.org>
Calendar

November 18 - 22
European Researchers in Didactics of Biology Conference
Location: University of Goteborg, Sweden
Contact: Dr Fred Brinkman, Secretary, IDO Vrije Universiteit, Amsterdam, Netherlands,
email: <fg.brinkman@ido.vu.nl>

1999

January 7 - 9
ASE Annual Meeting
Location: University of Reading, Reading, England
Contact: ASE Annual Meeting, The Association for Science Education, College Lane, Hatfield, Herts AL10 9AA, fax: +44 1707 266 532,
email: <asehq.telme.com>
The theme of this meeting is 'Science Education in the Computer Age'.
The Annual Meeting of the Association for Science Education attracts science educators from around the world. Don’t miss the substantial program of plenary addresses, papers, seminars, workshops, visits, displays and functions which makes this event one of the largest international gatherings of science educators. Following on the success of the 1998 ASE-ICASE-IOSTI International Seminar, a similar international seminar is being planned to precede the 1999 ASE Annual Meeting from 4 January.

March
ICASE NVON International Seminar
Location: Netherlands
Contact: Miia Rannikmae, ICASE European Regional Representative, Department of Science Didactics, University of Tartu, Lai 40 Tartu EE 2400, Estonia,
fax: +372 7 465 813
email: <miia@queenie.lai.ut.ee>

March 25 - 28
NSTA National Convention
Location: Boston, Massachusetts, USA
Contact: NSTA Conventions Department, 1840 Wilson Blvd, Arlington, VA 22201-3000
email: <conventions@nsta.org>
Join science educators from across the USA and around the world in a huge program catering to the needs of elementary/primary and secondary teachers of science and tertiary science educators. See the website for further information: <http://www.nsta.org>.

September 15 - 19
5th International HPSST Conference
Location: Pavia University, Italy
Contact: Dr Enrico Antonio Giannetto, Dipartimento di Fisica 'A Volta', Universita di Pavia, Via A. Bassi 6, 27100 Pavia, Italy, email: <volta99@pv.infn.it>.
This conference is being held in conjunction with the European Physical Society’s Interdivisional Group on History of Physics and Physics Teaching. The joint conference will contribute to local celebrations of the bicentenary of Alessandro Volta’s creation of the battery at Pavia University in 1799. See the website for more information: <http://www.cilea.it/volta99>.

October 4 - 8
3rd ICASE Latin American Symposium
Location: Curitiba - Parana State, Federal University of Parana, Brazil
Contact: Department of Educational Methods, School of Education, Federal University of Parana, Rue General Carneiro, 460 2o. Andar, Curitiba - Parana, CEP 80 060 - 150, Brazil.
Phone / fax: + 55 41 264 3574
Email: gioppoc@educacao.ufpr.br
The 3rd ICASE Latin American Symposium will be hosted by the Brazilian Association for the Advancement of Science - Parana Section, and will attract science educators from across the Latin American region and beyond.

2000

April 6 - 9
NSTA National Convention
Location: Orlando, Florida, USA
Contact: NSTA Conventions Department, 1840 Wilson Blvd, Arlington, VA 22201-3000.
email: <conventions@nsta.org>.

July 19 - 21
ICASE-CEFIC European Education-Industry Seminar
Location: University of York, York, UK
Contact: Miia Rannikmae, ICASE European Regional Representative, Department of Science Didactics, University of Tartu, Lai 40 Tartu EE 2400, Estonia,
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Extending and improving education in science for all children and youth by assisting member associations throughout the world

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Science Education International is the quarterly journal of the International Council of Associations for Science Education. ICASE was established in 1973 to extend and improve education in science for all children and youth by assisting member associations throughout the world.

This journal provides a means for associations, institutions, centres, foundations, companies and individuals concerned with science education, to share perspectives, concerns, ideas, and information which will foster cooperative efforts to improve science education, and which will serve as a chronicle of the advancement of science education throughout the world.

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Contents
ICASE News ................................................................. 2

Feature Article
Language and Literacy: a problem for America's science classrooms
Randy Terrick and Paul Vellom ........................................... 5

Science Education Around the World
Operationalising Scientific and Technological Literacy - a new approach to science teaching
Jack Holbrook, ICASE Secretary ....................................... 15

Teaching Materials and Strategies
Chem 0722 in the Chemistry Curriculum
Adolfo Obaya and Joaquin Palacios ................................... 20

Science Teacher Education
Science graduates' understanding of science processes
Hafiz Muhammad Iqbal ...................................................... 23

Research on Curriculum, Teaching and Learning
The science world view among Japanese people: their conceptions of the nature of science, technology and society
Yoshisuke Kusano ............................................................. 28

Assessment and Evaluation
Practicable taxonomy of basic skills of science practicals at secondary level for their assessment
R.S. Sindhia and Reeta Sharma ......................................... 34

Calendar ........................................................................... 38

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First Nepal Scientific and Technological Literacy Workshop

During one week in March a small but enthusiastic group of Nepalese science teachers met to learn about the UNESCO/ICASE Project 2000 + initiative. Then groups evaluated some of the STL materials developed in the region and elsewhere, before developing their own materials relevant for Nepal. The eight scripts produced are currently being edited for trial in Nepal secondary schools. They include titles such as: *Allow me to breathe comfortably*, *Improved kerosene lamps*, *Pineapple shaped wastebins*, and *The Naulo gaun free sweet story*. These units are very appropriate for use with the new upper secondary Science and Environment curriculum in Nepal, which has a strong emphasis on applications of science in the local community. In Nepal the Centre for Literacy Enrichment in Environment, Science and Technology (CLEST) has defined STL as the ability to understand and relate basic scientific knowledge and skills to everyday life and community needs in one’s own environment. CLEST seeks to promote relevant and meaningful environmental science education in schools and community with an emphasis on practical and personal involvement. For this reason Dr Sharada D Maharjan became involved in organising this first national workshop (previous ones had all been regional) with the help of Ms Annette Gueyva (UNESCO, Bangkok), Dr Jack Holbrook and Patrick A Whittle (ICASE). The workshop could not have taken place without the generous and practical support of Little Angels School, Kathmandu, where it was held. During his visit Dr Holbrook addressed two other meetings of science teachers, one to highlight trends in chemistry teaching at the secondary / higher secondary interface and another to explain the role of ICASE in promoting scientific and technological literacy. It is hoped that the Nepal STL approach will be replicated in other countries. It is expected that, in due course, copies of the trial materials and a report of their evaluation will be made available. Enquiries for further information about the first Nepal STL workshop, and its outcomes, should be addressed to Dr S D Maharjan, CLEST, PO Box 1007, Kathmandu, Nepal.

Photograph:
Participants in the Nepal UNESCO/ICASE Project 2000+ Scientific and Technological Literacy Workshop
Photographs: Participants in the Nepal Scientific and Technological Literacy Workshop.
Update on the ICASE Website
http://sunsite.anu.edu.au/icase

Check out the contact details of more than 140 member organisations of ICASE! Each member organisation with its own website is requested to send details so that a link can be established from the ICASE website.

Find out about the worldwide scientific and technological literacy project called Project 2000+. Exemplars of curriculum materials which have been developed in Project 2000+ workshops conducted by ICASE, will be progressively added to the site as a resource for science teachers.

For further information or to send updates for inclusion on the ICASE website, contact:

Brenton Honeyman
ICASE Past President
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ICASE Distinguished Service Award

This award is made to individuals who have a career history of distinguished service to international science education through their involvement in the international activities of local, regional and global science education organisations.

A listing of past award recipients can be found on the ICASE Website at <http://sunsite.anu.edu.au/icase/l_awards.html>

Nominations for this award must be forwarded by member organisations of ICASE. For full details of how to forward nominations, contact:

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Feature Article

Language and Literacy: a problem for America’s science classrooms

Dr. Randy Yerrick and Dr. Paul Vellom
Assistant Professors of Science Education
East Carolina University and the Ohio State University

Introduction

Most countries of the world hold their visions for education in high regard and science education plays an increasingly important role in defining the success of a national educational system based upon student achievement. Despite the international comparisons and studies of curriculum, teaching, and learning, we contend there are implicit school structures which promote inequity through the use of science content and instruction. Further, we contend that many of these structures fall along lines of language and ethnic boundaries and it is rare that any educational system avoids bias steeped in based language, ethnic, racial, or economic differences. We offer our critique of American schools to provide helpful insight to teachers, researchers, and reformers of national systems who struggle with deeply rooted cultural divisions or who may send students to American schools which have repeatedly demonstrated commitment to change but struggle against the harsh realities of social agendas at work in schools.

American science education reform calls for students to practice the “habits of mind” of scientific communities. Ideally, in a reformed classroom, students interact like scientists and act according to what scientists value as a group. At the same time, teachers are currently being challenged to prepare their students to construct and reflect upon scientific knowledge as opposed to simply receive it (AAAS, 1989, 1992, & 1995; NRC, 1996). The American Association for the Advancement of Science argues (AAAS, 1989) that science “must consist of more than the provision of correct answers” recommending that,

“Science teachers are now assuming greater responsibility for helping females and minorities learn to succeed in these fields (as well as mathematics). With concerns of domestic equity and international competitiveness, science educators must help ensure that all students have equal opportunity to succeed in science-related endeavors.” (AAAS, 1989, p. 166).

Equity and National Standards

Current United States’ science education reform rhetoric reflects a rethinking of what school science should be and promotes a revised version of what it means for students to act in ‘scientifically literate’ ways and practice the ‘habits of mind’ of scientific communities. Further, the evolution of science education reform over the past three decades has been more inclusive than earlier efforts. According to current reform documents (AAAS, 1989; NRC, 1996) ‘all Americans’ can and should learn such implicit values and practices of science regardless of their background or experience.

Included also in current reform vision are the pedagogical recommendations that teachers treat scientific knowledge tentatively, provide students with opportunities to reason using evidence, and help students work collaboratively in groups. Each of these key elements is a valuable component of scientists’ work, reflecting their interactions as members of a scientific community.

The student-centered, problems-based approach to the practice of teaching conveyed in the National Science Education Standards (NSES) intends to give students practice in kinds of real scientific experiences.
The NSES have been developed using a variety of perspectives to reconceptualize the national definition of scientific literacy. These include: 1) constructivist notions of learning and teaching (von Glasersfeld, 1989; Tobin, Tippins, & Gallard, 1994; Driver, Leach, Millar, & Scott, 1996), 2) evolving philosophical representations of the nature of scientific thought and activity (Duschl, 1990; Lemke, 1990), and 3) ethnographic, anthropologic, and socio-linguistic interpretations of thinking, speaking and acting members of a scientific community (Gee, 1989; Michaels & O’Connor, 1990).

**America’s school literacy has been historically prohibitive**

Current reform efforts in the U.S. are the first of their kind and unique in vision from those of the past. The largest science education reform effort in our nation's history was meant to produce the best and brightest scientists in a post-Sputnik era of international competition and commerce (DeBoer, 1991; Duschl, 1990). It is only recently that Americans have grown dissatisfied with the products of elitist visions for schools and their tendency to exacerbate differences between lower- and higher-achieving students. In light of growing discrepancies between majority and minority students' achievement in science, selection of science as a major, and placement into science-related vocations, increased national attention is drawn to the role of schools in promoting fair and equitable learning environments.

The United States is certainly one of the few countries espousing a standard of scientific literacy for all. But our allegiance is somewhat divided and threatens our ability to achieve what we hold up for ourselves as an ideal. Social pressures have molded our schools to serve certain beliefs and social values. For example, we believe that schools should be places in which all students have equal and unfettered opportunity. In opposition to such a belief, Americans also expect their schools to reward students differentially according to their degree of hard work and demonstrated achievement. Rarely is there public discussion of such discrepant egalitarian v. meritocratic beliefs which compete within our schools (Apple, 1979). Unlike other countries which have adopted a focused vision for scientific literacy, and have also accepted the consequences that relatively few students will actually acquire such practices, the United States continues to wrestle with privileging a relatively small percentage of its citizens with discourse which earns them power in society.

American schools have adopted certain structures to deal with such fragmented ideologies in the hope that the illusion of equal access will satiate public opinion—at least the powerful public. One such structure is ability grouping or tracking. To accommodate diversity of all kinds, American schools began to sift and sort the mass influx of students immigrating to this country at the turn of the century (Cohen, 1984; Oakes, 1985 & 1990). Only recently have scholars' critiques of these tracking systems taken center stage in educational reform. Decisions made on behalf of the minority students by parents, teachers, administrators, and evaluators often carry profound socio-economic consequences, without clearly explicating the assumptions upon which they are grounded (Bowles & Gintis, 1976). Some researchers' voices challenge the very assumptions upon which decisions are made (Goodlad, 1984; Cohen 1984; Oakes, 1985 & 1990) and argue that most assumptions are, at best, over-generalizations based upon minimal information, and at worst, overt exercises to reproduce existing societal structures and imbalances. Many scholars argue that without explicating the assumptions used to track, group, or otherwise prescribe educational efforts, great disparities will continue to be propagated in the access to different kinds of knowledge (Anyon, 1981; Oakes, 1990 & 1995; Willis, 1977). Feinman-Nemser, McDermid, Melnick, & Parker (1989) contend that grouping serves the needs of a powerful few, arguing that,

"While many parents and teachers believe ability grouping and tracking enables schools to address the individual needs of a child, research..."
raises questions about the purposes—as well as whose purposes—these practices actually serve.” (Feinman-Nemser et al, 1989, p. 10).

Ability grouping is a school structure promoted as a means to assist students, but instead provides a means to simply manage a more complex problem. It is a problem that will not likely be soon resolved until America recognizes the skewed nature of competing internal ideologies.

Identifying and grouping children through language.

Implicit in the NSES are certain notions of constructivism (von Glasersfeld, 1989; Tobin, Tippins, & Gallard, 1994; Driver, Leach, Millar, & Scott, 1996; Duschl, 1990; Lemke, 1990). In incorporating these notions of constructivism as a means for better understanding the cognitive processes involved in learning, many science educators have become advocates for broad notions of scientific literacy. However, these notions of scientific literacy become problematic when its ideas are not clearly articulated or fully understood by researchers, administrators, and teachers.

In their present form, the NSES provide no arguments or compelling evidence that would encourage teachers or administrators to reflect critically on how well their students are learning, on how relevant the curriculum is, on the lack of ethnic and gender diversity in their advanced science courses, and on the socioeconomic impact of discouraging diverse learners to pursue science-related careers (Rodriguez, 1997, pp. 31).

In short, if things are working smoothly for teachers or administrators, they see little need for change. For example, if a teacher of Advanced Placement physics notices a difference in the ethnic composition of his/her applied general science class, s/he may construct or adopt a variety of rationales for why this may seem normal or even appropriate.

While separating children into ability groups by race or ethnicity is often frowned upon, it is a more esoteric decision to place students into ability groups based upon their ability to speak English fluently. Despite the flawed assumption that intelligence and primary language are one and the same, students are often assigned special classes in school and are pulled out of regular classes for special help on the basis of their control (or lack of control) over the dominant discourse. In some cases, students’ home-based discourses actually served as detriments to their school success, participation, and ultimate membership (Au, 1980; Heath, 1986). It would be quite a different matter if schools were identifying ways in which home-based and school-based discourses could best be mapped for future scientific inquiry, engagement, and ultimate success. Schools instead use such language labelling and grouping to privilege those students who are already privileged. As Michaels and O’Connor (1990) have eloquently stated, “If you don’t come to school already controlling elements of the discourse, it never gets unpackaged for you.” (p. 24)

Venues which promote stratification, and seeds for change

Tracking is a complex and deeply imbedded practice in American schools, and both recent and past research has shown that it occurs for both organizational and social reasons (Oakes & Guiton, 1995; Garet & DeLany, 1988; Kerckhoff, 1976). Studies of the relationship between high and lower tracks and students’ career aspirations have shown that lower tracked students are significantly more likely to believe that they are suited for working-class jobs, rather than scholarly or professional positions (Rosenbaum, 1980).

Intertwined with these findings must be the current relationships between social class and access to school knowledge, particularly as illustrated by Anyon (Anyon, 1981). Students from lower SES schools tend to experience knowledge as disconnected, discrete pieces of information, and are less likely to see what they learn in school as relevant or important in the world in which they live. And, many students in lower track classes in middle-SES schools have similar experiences.
So, how do the children of recent immigrants fare when they enter American schools, especially in terms of tracking in a system where higher tracks provide access to (and in fact often support the development of) the dominant discourse? Oakes and Guiton, in their 1995 study of three California high schools, provide two examples of common barriers:

"Curriculum prerequisites were partly responsible for limiting less successful students' course taking opportunities. Foreign students at Coolidge faced difficulties in meeting college admissions requirements because they had to complete ESL courses before moving into college-prep courses. At highly competitive Washington, the screening process for college-prep science was stiff." (p. 15).

Within this example, we can see that both the structure of the curriculum and the social structure of expectations served to limit non-native language students' access to the higher tracked classes. In essence, the system served to direct students who faced challenges with language into the lower and middle track classes, where what is learned is less likely to be empowering to them in career and school endeavors, and which represents less robust images of complex subjects like science. We are confident from the multiples of examples in this research tradition, and from more recent discourse-based studies of science classrooms, that the trend illustrated here is widespread in American schools.

We draw upon the current research from Haitian immigrant (Ballenger, 1994; Warren, Rosebery, & Conant, 1989) and Hawaiian children (Au, 1980) to assist us in our understanding and work with local rural black populations. Mexican migrant workers, and poor, at-risk Caucasian children who attend the public schools we serve. We intend by no means to trivialize the plight of any one group or to generalize that the problem is the same for each group in each school. Rather our intent is to use examples from our and others' research to draw attention to regular school events and artifacts of tracking that might otherwise be obscured. The following represents an insider's critique of school structures and recommendations couched in our own teaching, service, and research.

Explicit and Implicit Curricula

We maintain two concerns regarding the explicit and implicit curricula offered to ESL students and other students falling outside of the college-prep track. Specifically these are: 1) the treatment of and access to knowledge, and 2) the explicit guidance students receive around standard course offerings.

Traditional science curriculum is highly compartmentalized and linear in its structure. If students have not entered in on the bottom level at the right juncture, then there is little opportunity for students to enter the higher level science at any point in their high school career. In addition, if students struggle with any one of the core courses offered, they risk falling out of favor with the rest of the system on the basis of incomplete pre-requisites.

The nature of knowledge that students have access to in different classes is quite varied. By way of example, consider the disparate definitions held for skills, competencies, and attitudes between two extreme student groups. Curricular and assessment artifacts reveal that groups of advanced placement students are expected to value sustained lines of logical thought, to invent and construct multi-faceted proof, improve themselves through competitive norms, and to thrive in a performance-based venue (such as the annual AP test). These explicit outcomes, and even the more tacit ones, differ from those held for lower track students. Curricular documents reflect the value of learning basic skills and performing computations. Concerned teachers look into the eyes of alienated youth and hope these students can learn to buy into school long enough for it to "pay off," that students may "make something of themselves," and become productive citizens in "what they are good at", and perhaps even learn to adapt in difficult family and social environments. In this way, the implicit as well as explicit curricula convey to students others' beliefs regarding their abilities and continue to maintain definitions of student skills and content competencies filled with
implicit social, political, and economic factors that shape the lives of children.

When teachers describe to us their school offering five or more different levels of biology, we can usually guess where the students who struggle with English are placed. What is alarming to us is that students who have been directed to take a more general science course quite often are receiving little additional assistance in mastering the content and language in the context of that class. These students may also carry a collection of other courses prescribed to them based upon a counselor’s direction which include Home Economics, Masonry, and other vocational courses. The school science curriculum is rigid and unforgiving for students who cannot keep pace or balance across all upper level core courses. In addition, counselors may serve as the gatekeepers of the system steering unwelcomed students away and reinforcing a homogeneously upper echelon. A strong illustration for us is the racial imbalance as we walk across the hall (or sometimes to the other building) from the homogeneously sorted accelerated students and see a collection of minority students who have an entirely different membership within the school—the same schools that label poor, black children minorities even in the contexts in which they are by far the majority—clearly an indication of the power of a dominant school discourse and the conformity it demands.

Redefining science curricula in the lives of all students is essential. Benchmarks (AAAS, 1992) is but a beginning for describing a new set of science standards for a variety of students and levels of understanding. Accepting the view of literacy implicit in the NSES implies new criteria for understanding and measuring scientific literacy. Adopting NSES signals a radical departure from traditional understandings of what it means to teach and learn science. Indeed, what is being called for here, is the intentional scaffolding and teaching of the discursive practices of science. In other words, achieving scientific literacy will require spaces where students and teachers engage in meaningful social practices which reflect those of scientific communities. Talking and doing science is culturally specific and must be learned as such.

Science Teachers

Traditional ways of assessing instruction have been to examine mainly how smoothly a particular lesson has progressed, and how well the teacher has handled managerial aspects of teaching. In classrooms in which there are many types of activity structures (e.g.: group discussion, lectures, group work, projects, laboratory experiments) teachers need to understand and know how to convey the rules for participation. These activity structures have built-in sociolinguistic patterns that are not always explicit. Many teachers who are reflective about their practice can easily recount innumerable examples of struggles with ESL students or other students in lower track classes. While teachers may have been socialized to equate struggles with failure, these same instances can provide insight into teachers’ practice. Classroom conflict can be an opportunity for teachers and their students to learn something explicitly about one anothers’ differences. In doing so, teachers not only gain the knowledge to anticipate potential points of conflict, they establish a place in which negotiation and true cooperation can begin.

Classrooms must be places where meaning is negotiated, but must also be places where the rules for obtaining those meanings are negotiated. Teachers should engage other teachers in critical examinations of their own learning experiences and teaching practices, and how these are related to their conceptual framework of what the teaching and learning of science is about. Teacher research becomes an important tool for accomplishing this an alternative learning experience for teachers to experience the above endeavor. Providing resources and rewards to teachers without structuring obstacles will not be sufficient to develop wide-spread successful scientific classroom communities.

Teachers are not always prepared in their teacher education programs to address diversity or issues pertaining to ESL students, nor are they experienced in learning science
in the way they are expected to teach. Teachers need some meaningful and rich ways of understanding concepts for themselves as well as delving into, for example, students’ conceptions and ways of assessing students’ learning. Teachers need the assistance and input of a variety of specialists and institutions in order to be successful with ESL students. Teachers are overburdened by a system that has failed not only students but them as well. Because of the lack of support offered and the challenges associated with teaching students homogeneously sorted based upon their failure in school science, few veteran teachers volunteer to teach such classes. The result is the passing of enormous responsibility to teachers of minimal experience with a marginal understanding of available resources and support for language assistance.

Community

Finally, we implore communities to work together for resolving the local biases manifest through cultural and historical practices. We must all consider ourselves in need of cultural enrichment. Floden, Buchmann, and Schwille (1994) contend that all homes are culturally impoverished, arguing if is good for minority students to learn English, then English speaking students would be equally enriched by learning another language. Floden et al call upon educators everywhere to intentionally and earnestly “break from experience,” for it is the commonality of everyday experience and our comfort within it that enslaves us.

The belief that good schooling requires continuity is an invidious myth. Breaks are necessary for all children to think and act with a sense of method and ideas that reach beyond the immediate. (Floden, Buchmann, & Schwille, 1987, p 494)

Communities need to help their schools understand the importance of finding science in the lives and talk of its children and how to best link up through issues based education or other types of partnerships. As demonstrated by many past and present efforts (Au, 1980; Ballenger, 1994; Heath, 1983; Warren, Rosebery, & Conant, 1989), school policies and practices can change to assist ESL and other students at-risk of falling through the cracks of an American system with divided loyalties. Change will not come in the form of science remediation for students, or even specific language tutoring alone. Let us not be misled. Breaking from experience will be a difficult and uncertain task, but the enrichment of all students’ lives will be the reward of those who act.

Final Comments

Scientific discourse is quite different from most home-based discourse, and the different rules of discourse should be made explicit if we want persons outside the discourse to have access to it (Delpit, 1988). Scientific discourse, as modeled through science education reform, is one which needs to be acquired and not learned (Gee, 1989). Introducing a foreign discourse (such as science) into cultural context presents different types of challenges in each setting, and the progression of change from home-based to science discourse should be explored with the goal to develop ways for not just replacing one type of discourse with another. Rodriguez argues,

“Perhaps one of the greatest strengths of the NSPS is that it intends to an issue that sociologists of education have been pointing to for years: that there cannot be changes in the culture of teachers without supporting structural changes in the institutions of schooling.”

(Rodriguez, 1997, p 21)

Reforms, despite their national allegiances and contextual origins, challenge us to create ways that all students, including poor students and students of color, can learn scientific discourse and at the same time not give up their home-based discourse-their identity outside the science classroom. Differences in students transcend language, race, gender, and ethnicity and, since science is such a major component of our intra-and international comparisons we must all pay close attention to the implicit structures and artifacts of our nations’ schools. We must refrain from labelling and prescription in light of new findings and definitions of schools and science and assistance if we hope to assist students in the quest for any kind of national vision for equity.
in science. Instead, we should focus our efforts on sustaining connections between culturally-based and scientific discourses and sharing our knowledge to keep school science from promoting inequity.

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Operationalising Scientific and Technological Literacy
- a new approach to science teaching

Jack Holbrook
ICASE Secretary

I could repeat my example in many different areas where science impinges on our daily lives yet where school science education is of little use. Although school science tries to develop conceptual understanding in students and an appreciation of the way scientists do things, its relevance to society is suspect (Pak, 1997; Yager, 1996). The understanding and scientific method tends not to be relevant for functionality in our lives i.e. relevant to the home, the environment, future employment and most definitely for future changes and developments within the society. Rather the understanding tends to be geared to internal concepts within the subject itself. Concepts such as pressure or chemical bonding are almost universally chapter headings in science courses, yet in daily life, inflating car tyres correctly to minimise accidents, or selecting appropriate moisturising creams for the skin, are much more relevant starting points.
To a large extent science education in schools is not relevant (Champagne et al., 1985; Lederman, 1992; Novick and Nussbaum, 1981; Osborne and Freyberg, 1986; Ryan and Aikenhead, 1992). Largely, this can be suggested because it puts the subject first, the application second. It forgets that relevancy is in the processes and products we utilise, and only afterwards in the understanding by utilising scientific principles. Thus, in terms of relevant conceptual learning, it would seem the approach is suspect. It would seem we need to take note of the situation first so that the conceptual learning that follows can be seen by students to be relevant (Holbrook, 1994).

And relevancy goes beyond the acquiring of knowledge or conceptual understanding. It encompasses also attitudes towards the learning of science and the making of decisions geared to societal concerns e.g. ensuring sustainable development and the development of social values. These are areas that are rarely considered in science courses. Science courses forget that whilst education encompasses such goals, science education is an integral part of this very same education.

Scientific and Technological Literacy for All (STL)

Taking all the attributes and, for want of a better term, the relevant education for which we strive can be expressed as ‘Scientific and Technological Literacy’ (STL) (Holbrook, 1997). Unfortunately this is not a static target and also can be achieved in various levels (BSCS, 1993; UNESCO, 1997). And as a concept, there is no specific definition. It is ‘scientific’, because most definitely science concepts and the manner in which problems are approached (scientific method) are very much relevant to an understanding of our world of today.

It is ‘technological’, because, for relevancy, the processes of technology are heavily intertwined with those of science. It is probably fair to say that whenever you look around, it is the products from technology that you see; not the science. Yet the process by which the products are formed are likely to be based on scientific as well as technological know-how.

And ‘literacy’, because it is no good having conceptual understanding if it can’t be utilised. It is no good knowing science if it cannot be communicated to help solve problems or handle decision-making for concerns within the society. It is also no good if science education does not contribute to the development of social values, personal interests, personal responsibilities and career enhancement. And finally, it is no good if science education in schools is not preparing students for the world of tomorrow, able to face up to the multitude of changes and challenges - if you will, coping with change and learning to learn.

The literacy component

Even in situations where the scientific and technological learning within curricula can claim relevancy, the literacy aspect is sadly missing. Literacy is an area that goes beyond the textbook. It is an area that depends on the vision of the teachers, the recognition of research findings that stress the advantages of student involvement, constructivist approaches and the role of the teacher as a facilitator (rather than provider of knowledge). In some countries, the inadequacy of worksheets, unless used by teachers merely as support material, is of grave concern because they pay scant attention to the literacy dimension.

On the one hand it is the literacy dimension that suggests relevancy in science education curricula has a uniformity across education systems around the world. The striving for conceptual understanding and the process of tackling problems in a scientific manner have worldwide applicability. But, on the other hand, relevancy means that curricula around the world need to reflect the concerns, priorities, customs and heritage of the local society. In this aspect of relevancy, the context for science curricula needs to be unique to the different societies.

Education for Scientific and Technological Literacy

STL education sets about preparing citizens for life within the society, both for today and the future. By preparing for life within the society, it is intended that students acquire skills and attitudes so as to be able to:

(i) undertake further education of choice and be empowered to secure rewarding employment;
(ii) function in a positive social manner within society;
(iii) adapt to, and be prepared for, change in the future;
(iv) play a responsible role as a citizen within the society.

The goal of science education can surely be nothing less than to aspire to STL. This means it is a much more human, caring approach than an academic
pursuit, even though it still leads to an appreciation of the scientific method and the acquisition of scientific concepts. An important goal of science teaching is to meet the challenge of operationalising STL.

**Teachers teach students, not science**

So far, the approach to combatting the tremendous changes in modern technology, has been to design new curricula that strive to incorporate a more up-to-date image by including topics such as biotechnology, plastics, electronics, etc.

But surely this is not the answer. This merely modernises content. Such science education still carries an image of isolation from the needs of the ordinary citizen. The conceptual understanding is still inwards looking towards the subject discipline. And if we are not careful, science continues to be associated with pollution, danger and health hazards. The term ‘chemical’ refers to something poisonous and definitely not to be found in the home. The average person continues to be ignorant that foodstuffs are chemicals, the multitude of painkillers and other pharmaceuticals used at home are chemicals and even the petrol used in the car or the paints and other decorations of the home are also chemicals.

So what is the answer? Obviously it would not be fair to claim any one approach can be the sole response. Changing public opinion by attempting to combat ignorance of the role of science education is certainly a factor. But the factor put forward here, which has not received the attention it deserves, is perhaps the major component for the lack of change in school teaching of science subjects. That factor is *the vision of science teaching by teachers themselves.*

Perhaps more than in any other subject area, science teachers perceive their task as teaching the subject matter (Aikenhead, 1997). They see their task as imparting knowledge and understanding of the principles that underlie this knowledge (Romberg, 1985). The feeling is so strong that ‘completing the syllabus’, as exemplified in the textbook, is a common science teacher cry. Experimental investigations are given a low priority, especially if the external examination places little weighting in this area. Assisting students to develop skills of problem solving is not taken seriously, unless this simply means tackling a variety of numerical problems. Time is certainly not to be set aside for planning an investigation and then carrying it out, or for decision making situations where the answer is not clear cut and a multitude of factors can influence the decision, such as economic, social, environmental, political, or ethical considerations.

It would seem that teachers continue to teach the content of the subject for a variety of reasons. One important factor is that textbooks, for the most part, ignore non-conceptual areas, preferring to include applications within the society of science concepts studied, rather than starting from society’s way of utilising science. The textbook emphasis and approach, of course, is heavily influenced by the manner in which the curriculum is put together. For convenience, curricula are almost invariably put together based on science fundamentals, grouping science concepts together for scientific convenience. Curricula rarely group learning based on the way society makes use of science e.g. for solving issues/concerns in the kitchen, the bathroom, the local environment, industry and employment.

**Avoiding change**

Evidence suggests that teachers try to avoid change, especially change that demands their expertise may be undermined (Aikenhead, 1997). Science teachers have not had to deal with the development of societally useful problem solving or decision making skills in the past. Teachers have not had to deal with the development of the student as a member of society, or the development of societal skills (so as to be a responsible member of society) during science lessons in the past. Thus science teachers are uneasy about bringing ethical or social values into the science classroom, even when these have great relevance to the society (Gaskell, 1982).

So what happens, if a curriculum led change is contemplated? If the curriculum tries to introduce a greater range of educational skills and for this, reduces the science content, teachers tend to utilise this ‘extra’ time to delve more deeply into the subject matter. Teachers avoid the incorporation of student centred activities such as brainstorming, role playing, small group discussions, and creative activities such as developing posters, composing letters to officials, raising environmental awareness and participating in debates. These do not move the content forward. Teachers’ practical knowledge determines classroom practice (Duffee and Aikenhead, 1992). Even activities that have the potential to increase content knowledge are avoided e.g. library searches, location of secondary information sources, because these would not be under the control of the teacher.
The science teacher is thus happy teaching the subject. Their efforts are increasingly irrelevant to the modern society. They ignore cries for more feeling and caring in science lessons and a greater societal relevance. They have been given a subject curriculum and covering that is their perception of their task.

Teachers teach the way they are taught! (Gregorio, 1997) As a consequence, science becomes impersonal, increasingly irrelevant and in the hands of uninterested teachers, a memory exercise. It is in changing this viewpoint that Science Teacher Associations need to make headway (Haggis, 1991). These neglected areas in science education are important in educating students. No wonder in the past students found science difficult; no wonder girls tended not to choose this option; no wonder primary school teachers shied away from teaching science.

So what can be done? How to operationalise STL?

No innovation in science education has been successful without the support and expertise of classroom teachers’ (Holbrook, 1996; Pak, 1997; Purkey and Smith, 1982; Roy Singh, 1991; UNESCO, 1997). Helping and supporting the teacher is crucial.

First and foremost is the need to change the teacher’s perception of what science teaching is about. Science teachers need to be guided to teach students. And this means playing their part in meeting the educational goals put forward for schooling. Science teachers must realise that education is not solely about concepts and content, but requires attention to personal and societal skills, to ethical considerations and above all, it requires attention to the affective domain. Science education must be seen as part of education.

Whilst this is easy to say, it is not so easy to put forward guidance as to how change should be achieved. But at least 50% of the battle is in getting science teachers to perceive they need to change; the curriculum is wanting them to change and the society as a whole (this influences the Ministry of Education) wants them to change.

The task before us is to get science teachers to change for a new image of science education - STL for All. This image cares about the students as individuals. Science teachers reflect on how to teach students, not content. Teachers develop new approaches to teaching that encompass a greater degree of student-centred teaching (Gunstone, 1997), more attention to relevance within the society, to values education and above all, science teachers give attention to the development of personal qualities and positive attitudes towards the role of science in the society.

Without doubt, contemplating change means teachers need in-service support. But this in-service provision needs very careful consideration to address the real needs of teachers (Cho, 1997). Telling teachers to change is not likely to help the situation. They need to be shown how, and to appreciate why, this is the manner in which to change. Teacher trainers must be convinced of the need to change and for change to actually occur, teachers need to be convinced how the change can be successfully implemented.

Convincing teachers to embrace change

Two aspects are put forward here.

(a) One aspect is to provide research evidence showing change can lead to substantial gains by students and, very importantly, that students do not suffer in their ability to pursue science courses at a higher level (Boyer, 1983; Byrne and Johnstone, 1988; Goodlad, 1984). Such evidence is also needed to convince University science faculty staff, who are often the most skeptical of all persons involved in school science curriculum development. University teachers’ concern is that students will gain the required background and prowess to cope well with the demands of University science courses and, if coped with successfully, to then be able to continue (even though this applies to only a very, very small number of students) and be able to pursue scientific research.

What research evidence there is, shows that pursuing higher order thinking skills is more rewarding for students than factual memory exercises, even though they cover less material. Research evidence shows that positive attitudes are enhanced by greater societal relevance and by more student involvement, even though content coverage is much lower. And research evidence shows that positive attitudes leads to greater academic gains. Provided the examination, or the student assessment indicator, are well prepared, the students achieve higher when showing a more positive attitude towards the subject and are able to use a range of educational skills (Kellerman, 1993; Liu, 1997; McCormack, 1996; Weiss, 1993).

(b) A second factor is providing suitable in-service courses (Yager, Hiddayat and Penick, 1988). One approach that shows signs of success is to encourage teachers to reflect on the changing needs of science
education and then, with this in mind, to develop supplementary teaching materials that meet this need. Science Teacher Associations (STAs), whether large or small, can play an important role in this provision. Teacher workshops which pay great attention to the philosophy of STL, as developed by ICASE (Holbrook and Rannikmae, 1997; UNESCO Resource Kit on internet), can get teachers better prepared for science education for the 21st century. Giving teachers ownership of this philosophy, by teachers creating supplementary teaching materials which meet STL criteria, becomes the main focus of the workshops.

Criteria for Exemplary STL Materials
The criteria being suggested for the creation of exemplary STL supplementary teaching materials (Holbrook, 1997; Holbrook and Rannikmae, 1997) are:

a) Promotes student achievement in a range of educational goals
   - a wide range of education goals are stipulated and form the major focus of the material i.e. students are participating in the process of educational learning, appropriate for the goals of the country and their intellectual development. These goals not only relate to science concepts and scientific method, but also include social values and the development of personal skills.

b) Starts from a concern or issue in society
   - the material is societally related and draws on an issue or concern within the society. Students are familiar with the situation, can thus appreciate its relevance and are able to build on constructs already formed. The material is directly relevant in the eyes of the students. Creating material on pressure, or bonding or photosynthesis is not, it is suggested, directly relevant because the relevance is not overt. Creating materials on the correct inflation of car tyres, moisturising the skin, or the Amazon rain forests is relevant. The relevance is clear even though the conceptual science may not have changed.

c) Involves demanding (higher order) thinking skills
   - undertaking the activity is an appropriate learning exercise for the learner i.e. it provides an intellectual challenge at an appropriate level for the students. It utilizes constructivist principles - moving from information and understanding already in the possession of students, to the new learning situation. It involves analytical or judgemental thought.

d) Student participatory
   - the teaching approach and activities are designed to be student participatory i.e. students are involved either individually or in groups for a considerable amount (>60%) of the teaching time. This does not necessarily mean that the teaching material is experimentally orientated (although this is considered important), but it does mean attention is paid to the incorporation of a variety of teaching approaches through which students can participate.

e) Includes a communication skill component
   - due consideration is given to enhancing a wide range of communication skills appropriate for the dissemination of scientific ideas and social values.

f) Relates to science education
   - whilst the material links science teaching to social science, particularly by the scenario from which the material is developed, the teaching still contains a substantial component of 'standard' science and students are given ample opportunity to acquire scientific concepts. The material is definitely education through science, not a social science add-on.

g) Includes a comprehensive teacher’s guide
   - as problems, issues and concerns coming from society are often interdisciplinary in character, with the science ideas unfamiliar to the teacher, full explanations are needed to help teachers make use of the materials in a meaningful and interesting manner.

How should teachers acquire this direction and utilise STL materials?
The simple answer is for teachers to participate in STL in-service courses, be introduced to the criteria and then to try to create their own teaching materials. If teachers can do this (and it is by no means an easy task) and the newly created material reflects the new direction of teaching, then by using this they will be operationalising STL in the classroom (Rannikmae, 1997). The new material will take into account automatically the widening vision of science education.

If teachers choose not create the material themselves, but use existing material, they still need to ensure they are conversant with the new STL vision of education. This means they need to accept the idea that science education starts from a social concern or issue before progressing to the science method and scientific concepts. And that science
education involves social values and personal
development as well as science conceptual ideas.

**What else needs to be considered?**

A teaching goal, often stated in developed countries,
is that the teacher needs to become a facilitator,
helping and guiding the students, rather than a
fountain of knowledge, reproducing the textbook. STI
materials are designed for this.

Teachers will not wish to use the materials all the
time. The materials are not the actual curriculum. The
materials are simply ideas to guide and change the
direction of teaching. Teachers use the materials as
and when they feel it appropriate. But their use is a
start along the crucial path of change.

The approach to using the materials and exemplar
materials is described in Supplementary Teaching
Materials, an ICASE publication. Single copies are
available free, on request, to STAs that are members
of ICASE. Individuals can purchase a copy (£12.50
sterling, including postage. Contact the ICASE
European Representative - address given at the front
of the journal). The approach, and additional
materials, are further described in a Resource Kit
being compiled by UNESCO (contact STE,
UNESCO, Paris) and additional materials are given in
an Asian publication by UNESCO, Bangkok. A future
article will elucidate exemplary teaching materials
developed in this manner.

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**Teaching Materials and Strategies**

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This section focuses on classroom ideas, student activities and new curriculum materials which will assist teachers and teacher educators to enhance and enrich their programs.

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**Chem 0722 in the Chemistry Curriculum**

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**Introduction**

Chem 0722 is an important subject in our Chemistry curriculum in the applied experimental chemistry department. This subject is a formal way of teaching students about research by studying the primary literature. Until recently we relied on a classical approach. Due to low student participation, we have revised the format entirely. Some authors have expressed similar dissatisfaction (Felder, 1988; Blackburn and Wiseman, 1990).

The applied experimental chemistry group at UNAM-Cuautitlan consists of six faculty members, and five to twelve senior majors graduate each year. All majors are required to take Chem 0722. The academic calendar consists of three 10-week terms and classes for one hour each week throughout all three terms. Students receive a single grade at the end of three terms and receive credit equivalent to a normal lecture course.

**Former Model**

Initially we followed a fairly typical design for our subject. During the fall term, each student selected a topic from a list provided by the faculty, for instance polymer chemistry. A leading reference to a recent research article was included with each topic. The student then wrote a short report, which was due at the end of the term. All classes during the fall term were given by the faculty and by invited speakers. In the fall term each student gave a 30-minute seminar based on the topic selected. Students were also required to write an expanded report paper, which was due at the end of the term.

During the spring term, students gave a 50-minute presentation either on their independent research project or upon a new topic. In fall and spring terms, classes by invited speakers were programmed during the semester.

The students made two presentations, wrote two papers, and attended more than 30 sessions.

Every year the faculty were unsatisfied with the result of Chem 0722, and we decided to modify the format because four problems were present:

- Too often student presentations demonstrated little work beyond reading a single research paper.
- The paper topics were not connected in any way, so there was no reinforcement of any of the material. After learning thirty different topics, students retained little.
- Most of the time, the students were not very active. Except when presenting his or her paper, a student simply listened to the presentations. Students were not asked to demonstrate that they had learned any thing (for example, by exams or quizzes).
- At the end of the year, students had read relatively few papers as part of the class activities.

**Novel Model**

Several years ago during the 1994 fall term, we decided to completely change our Seminar format. In doing so, we first formulated our goals. We
wanted students to learn to (i) read the chemical literature, (ii) discuss the literature, (iii) present a seminar, (iv) write a short paper, and (v) evaluate research strategies. Finally, we wanted them to get excited about research and research literature. To achieve these admittedly ambitious goals and to avoid our earlier problems, we made a number of changes in our approach to the learning-teaching activities. First, we decided to choose a specific topic for the presentations each year. For example, the first year we studied analytical chemistry techniques, and the second year we reviewed some topics in industrial chemistry. This action alleviates some of the disconnectedness of the old format.

Other seminar series have been organized around themes - for example, talks by alumni (Hill, 1978) - but our approach allows building upon the material learned each week. We also realized that giving everyone a common topic would allow students to participate more actively by the previous reading of the materials during others' presentations. Therefore, we now require from the students a discussion in addition to a presentation and besides the former activities, a group of four students has to make one video related to the presentation theme. This video should have fifteen minutes of running time.

As mentioned before, during the fall term, each student chooses a topic from a list provided by the faculty, accompanied by a leading reference, and a date is assigned for discussion. Each student then is responsible for reading and understanding the article. This, of course, involves further literature reading and background preparation in addition to carefully reading the paper. The student provides the paper and a list of discussion questions one week before the assigned presentation and discussion. The selected questions must be reviewed by one faculty member, before being distributed to the group. The student then leads a discussion of the topic and is graded upon his/her knowledge, preparation and quality of the presentation. Other students are given a satisfactory or unsatisfactory grade based on their participation on the discussion and questions. The list of selected questions not only helps students understand the paper, it also keeps the discussion focused. Students submit a short (4-6 pages) paper on their topic at the end of the term. Written evidence for a CAS on-line search must be submitted with the paper.

For the end of the fall term, students find a new topic within the common subject area, which must be approved by a faculty member, and they give a formal 45-minute presentation. It is required that the student practices in front of a single faculty member at least one week before the formal presentation. The student provides to the faculty and other students one leading reference for reading before the presentation. Participation by students in the audience during the answer/question period after the seminar is marked satisfactory/unsatisfactory. At the end of the term, each student submits a written 6 to 10 page paper on his or her topic.

By spring term, we feel that we have sufficiently explored our common topic. Each student makes another presentation, but the subject matter is unrestricted. Most students present the research from their independent study projects. Also during spring term, we invite outside speakers from nearby universities. It has become a tradition in the spring term to convene the junior chemistry majors to discuss the subject of Chem 0722 for the next year.

Table 1. Comparative analysis of the activities for the old and new format of classes in Chem 0722

<table>
<thead>
<tr>
<th>Former</th>
<th>New</th>
</tr>
</thead>
<tbody>
<tr>
<td>The students:</td>
<td>The students:</td>
</tr>
<tr>
<td>- select a research topic from a list provided by faculty</td>
<td>- search the chemical literature</td>
</tr>
<tr>
<td>- get leading reference on selected topic</td>
<td>- summarise and discuss the chemical literature</td>
</tr>
<tr>
<td>- give an oral presentation about his/her topic</td>
<td>- give an oral presentation about the articles found and discussed</td>
</tr>
<tr>
<td>- write a short paper</td>
<td>- evaluate research strategies</td>
</tr>
<tr>
<td>- write an extended paper</td>
<td>- get involved in the research process</td>
</tr>
</tbody>
</table>
Grading of discussions and presentations and criteria for the students' participation are discussed and shared by faculty members. Comments by faculty are recorded on a standardized form. It includes: student understanding, quality of discussion questions, ability to explain details, evidence of research and preparation, other comments and grade. A faculty member collects the comment sheets and discusses them with the student.

Students submit two copies of each paper, and two professors grade the papers independently. Each student receives the average of the two grades.

Discussion

Although we instituted the discussion requirement with hesitation, it has certainly been the most successful component of the Chem 0722. After four years of working under the new model, our students are very proficient at having discussions. They know how to support their point of view. Having topic areas with pertinence outside of chemistry generated more interest. Frequently discussions consumed more than the allotted time with no impatience shown by the students. Another benefit of the discussion is that the written papers are improved by the results of the discussion; weaknesses demonstrated in the discussion format can be addressed as the student researches and writes the paper. Finally, we have found that in the past three years, students are much more likely to ask questions at the end of formal presentations than they were in the past. We attribute this difference to the open atmosphere established by the group.

We want to point out that it is important to choose topics that are interdisciplinary within chemistry. For example, in the chemistry of the five senses (taste, sight, etc.), papers are largely biochemically oriented. This topic is reviewed in the first semester, which covers all areas of chemistry. Another problem is that in finding their own articles, students are tempered away from the primary literature for example by articles in Chemical and Engineering News or in the A-pages of Analytical Chemistry. We now encourage the students to have one research article and one article written for a more general audience. Both articles are discussed.

Finally, in their enthusiasm, professors sometimes take over the discussion. The student discussion leader usually is reluctant to assert himself or herself to regain control. To solve this, we have a single faculty responsible for discreetly directing attention back to the student. In fact this was a problem we had under the old format during the questions period after the presentation. We now apply the same solution during the questions period as well.

Conclusions

We have developed a new format for our Seminar with which both students and faculty members are very pleased. After three years in practice, we find that the new format encourages discussions, requires more reading and active participation and is more interesting than the former format.

References


ASE ANNUAL MEETING
The University of Reading
7-9 January 1999

Following the highly successful International Seminar Program held in conjunction with the 1998 ASE Annual Meeting, the Association for Science Education is planning an international meeting as part of the 1999 ASE Annual Meeting at the University of Reading.

For further information about the ASE Annual Meeting, contact:

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Science Graduates’ Understanding of Science Processes

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Institute of Education and Research, University of the Punjab,
Quaid-e-Azam Campus, Lahore, Pakistan

Introduction

About three decades ago when studying at college level, we were given the definition of science as “a collection of facts” or “an organised body of knowledge”. This view of science had implications not only for science teaching in the class, but for the development of curriculum, text-books and assessment practices as well. Text books of science gave information about those facts in an encyclopaedic manner and teachers transmitted this information to their students in expository fashion. Many times, text book recitation was a predominant method of teaching science. When it came to the assessment of students’ achievement in science, maximum care was taken to test memorisation and recall of facts.

Many years later, during professional training, we were told that science is not characterised only by “product”, that is, facts and information gathered by scientists over a long period of time. Contrary to this popular view, the way of collecting this information is also important. Then science is described as scientists’ ways of working and arriving at certain conclusions. That is, ‘processes’ of science are equally important as the ‘product’ of science.

But, paradoxically, this nature of science has not been emphasised effectively. Like many other developing countries, teaching and learning of science in Pakistan remained almost unchanged for years. Even today, the ‘product’ nature of science is kept in front and the process aspect behind. Despite their widespread recognition and importance, process skills are neglected in typical curricula. One reason is that many teachers are not trained to teach these skills to students. Thus, in spite of theoretical pronouncements at various occasions, actual practice of classroom teaching is the same as it was 30 years ago. Development of science process skills, an inquiry approach and constructive learning is still a distant reality. Many educators of science today believe that teaching of science that emphasises a traditional view of science has little pay-off. Development of real understanding of concepts and ideas in science necessitates the use of activities that provide students with opportunities of manipulating the material and exploring ideas by themselves. Use of science process skills during science teaching is as important as teaching of science itself. As Carre (1981) puts it:

“Modern science curricula are meant to provide a grounding for understanding the nature of scientific knowledge by developing the intellectual processes of science. The discipline of science demands a range of mental activities, processes such as classifying, communicating, controlling variables, designing experiments, interpreting data, hypothesising, predicting, and ....the most of all observing. But the point of these activities may be lost on many of the pupils if they are not accompanied by complementary activities which provide opportunities to reflect upon what is being done” (p. 6).

Similarly, Harlen (1983) further explains that there are two components of science. Firstly, the knowledge of specific facts and general concepts and secondly, the processes or investigation skills and
attitudes related to conducting an enquiry and finding out solutions to problems. The first component is called 'product' and the second the 'processes'. Both components are essential for learning and understanding science. Neither can be ignored. Both are part of the process of understanding nature.

It is because of this realisation that modern science curricula in many parts of the world have been changed drastically. These curricula put great emphasis on these skills in addition to imparting knowledge to students. During traditional teaching students are explained a particular topic or concept, and then at the end of a week or so they are required to spend about two class periods on practical activity. These experiments are meant to verify certain facts and prove, for example that the melting or boiling point of a substance is the same as given in the text. If the purpose of such activities is to help children learn specific facts about their environment, it will be achieved, though not to a considerable extent. On the other hand, if the purpose of science teaching is to develop concepts, more general ideas or enquiry skills that would help children to learn more about the environment through their own enquiry, such laboratory activities will not suffice. There is a need to provide multiple opportunities for exploring and manipulating materials, the cumulative effect of which will help develop general ideas and enquiry skills in children.

Science Processes

Harlen (1983) provides a list of skills relevant to young children. These skills are:

a. observing;

b. raising questions;

c. proposing ways to answer questions through fair tests or comparisons;

d. finding patterns in observations;

e. applying ideas to new situations;

f. communicating ideas to others; and

g. using simple measuring instruments.

She is of the view that older children of 10-14 years should be able to employ the following additional skills in their endeavour to make sense of the world around them:

a. defining questions which can be answered by experiments;

b. proposing an hypothesis;

c. identifying and controlling variables in carrying out investigations;

d. recording observations systematically;

e. using evidence critically and logically;

f. making measurements with appropriate accuracy; and

g. communicating information in the most appropriate form.

A rationale of emphasising these processes in science teaching is that these processes enable individuals and the society at large to approach their problems in a systematic and orderly fashion. They will develop an approach to problems that is not only scientific in nature, but social as well. These science processes are basically thinking processes that can be applied to any set of problems (Hernandez 1991). Thus, as claimed by DES (1985) "Each of us needs to be able to bring a scientific approach to bear on the practical, social, economic and political issues of modern life" (pp 2-3). The development of these skills is not sole prerogative of science. However, science does provide a context, opportunities and an environment conducive toward the development of these skills provided science instruction is arranged with this objective in mind. If these processes are made part of the instructional process, then there is every likelihood that a majority of children, if not all, will become more skillful in using these processes consciously and deliberately to make sense of natural phenomena. This may be one of the reasons that many educators and writers in the last decade or so, for example, Bentlely, & Watts (1989), Harlen (1992), RECSAM (1991), have stressed the development of these skills through science instruction.

But, despite their importance and despite the fact that the development of these processes has been advocated in many curricular documents, one is utterly dismayed to learn that nothing substantial has been achieved in this regard. In order to find to what extent science graduates and prospective science teachers are skillful in using these processes, the following survey was undertaken.

The procedure

A few years ago, I was demonstrating the "Cartesian diver" activity to explain to a batch of in-service science teachers various processes of science. The dropper that I used for demonstration was made of plastic and could not stand vertically in a bottle which was half filled with water. Thus, when the
plastic bottle was squeezed, it did not dive/sink to the bottom. When it was fully filled with water, it either sank down or movement of water into the dropper could not be observed when pressure was exerted on

![Image: The cartesian diver with a weight]

the walls of the plastic bottle. I made a little innovation. I fastened a small pebble to the stem of dropper as shown in Figure 1. It made the dropper stand vertically. When pressure was exerted on bottle’s walls, the dropper sank to the bottom, and when pressure was released, it floated again. During the demonstration one of the teachers asked why the dropper sinks when pressure is exerted. Instead of answering the question, I threw the question back to the teachers. To my surprise, one of the teachers said that the diver sinks because of the weight of the pebble. Many teachers agreed with her. They were unable to realise the apparent contradiction in their explanation, that when the bottle is not squeezed the weight is still there but the dropper did not sink.

Realising this state of affairs, I conducted a little survey of respondents answers to various questions relating to the same activity. This was a group of prospective science teachers, having a first degree in various science subjects and doing their masters degree in science education. This time, the activity was made a little bit more complex. Two droppers were used instead of one. One dropper was filled with water, less than half, and this floated on the surface of water more or less horizontally. The second dropper was filled more than half and this floated vertically in the bottle. When the bottle was squeezed, the vertical dropper sank down while the horizontal dropper still remained on the surface. The activity was demonstrated to trainee science teachers and they were asked to answer the following questions.

1. What change did you observe in the system?
2. What happened to the level of water in the bottle?
3. Why one dropper sank to the bottom?
4. Why second dropper floated on the surface?
5. How will you investigate the real cause of diving?

Survey Results

The purpose of the first question was to help respondents to focus on particular aspects of the system and on various events. Responses are given in Table 1. It is evident that all respondents noticed changes in the system, that is, the rise of water surface in the bottle, sinking of one dropper and floating of the second one. However, very few respondents were able to observe change of water level in the droppers, particularly in the ‘diver’.

<table>
<thead>
<tr>
<th>Questions</th>
<th>% of correct responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 What change did you observe in the system?</td>
<td>92</td>
</tr>
<tr>
<td>2 What happened to the level of water in the bottle?</td>
<td>72</td>
</tr>
<tr>
<td>3 Why one dropper sank to the bottom?</td>
<td>38</td>
</tr>
<tr>
<td>4 Why second dropper floated on the surface?</td>
<td>10</td>
</tr>
<tr>
<td>5 How will you investigate the real cause of diving?</td>
<td>zero</td>
</tr>
</tbody>
</table>

More importantly, only a few students could give a plausible explanation/hypothesise about the sinking of one dropper and not the other one. On the one hand, the results of this survey indicate an inability on the part of science graduates to employ science process skills to make sense of the natural phenomenon. On the other hand, this reflects a lack of understanding of an important scientific concept that these graduates have studied extensively during
traditional science courses. This fact alone shows that science graduates are unable to observe the system and its parts keenly and minutely and to propose a plausible hypothesis. It is understood that lack of this ability on the part of science graduates is because of a lack of such opportunities during their science classes that would help them to develop these skills. Surprisingly, all of the respondents did study ‘density’ in one of their physics course at matriculation and higher secondary levels. They should have been able to answer these questions had they really understood the concept of density. Science graduates should understand that if a dropper is floating on the surface, its density must be low. Because of pressure on walls of the bottle, more water enters into one dropper and not the other, thus increasing the weight of the diver and not the one that floats. If they are asked to explain the concept ‘density’ they can give full descriptions with the help of \[ D = \frac{M}{V} \] equation. So they have memorised the description of density but have not understood the concept.

Discussion

Since the independence of the country in 1947, various attempts have been made to change the science curriculum to fulfil the demands of a changing society. The first massive exercise of this nature was carried out twenty years after independence, that is, in 1967. A second effort was made in the early 1980s and a third one in the 1990s. But, if all these revised curricula are analysed from the point of view of its emphasis, it is clearly revealed that all these curricula put greater emphasis on the product nature of science. Despite claims made in the curriculum documents produced by the Ministry of Education, text books for these curricula and the actual classroom teaching remained the same.

Now the Government has recently announced its education policy in March 1998. This policy pronounces the enrolment at least 50% of students from matriculation to higher levels in science based disciplines. At the same time, reforms in the curriculum and assessment system are also being proposed. Thus, it is high time that the true nature of science be acknowledged and reform movements be carried out accordingly. If the real purpose of teaching science is to promote understanding of scientific concepts and the development of enquiry skills in students, then it is imperative that the process aspect of science be given an added emphasis. This does not mean that the subject matter content should be ignored. There is no denying the fact that some curricula in the past pressed process teaching so hard that they neglected the subject matter content to a large extent. On the other hand, traditional science courses, which are dedicated to covering an encyclopaedia of correct answers and showing the structure of a particular science discipline, tend to cover as many science facts as possible. Students are expected to memorise isolated bits of information for tests and credits rather than construct their knowledge for personal use in their everyday lives. Much factual material may be learned by the children from books or other sources. Both of these approaches to teach science are undesirable. There must be a balance between the process aspect and a product approach to science teaching, because both of these aspects are inseparable components of science. However, development of process skills will not take place through traditional teaching. It is to be recognised that subject matter content is important for development of science process skills. In Gagné’s words (Gagné 1985, p. 238), “Application of science processes requires an understanding of subject matter content”. But it is also imperative that students be provided with opportunities for processing information and data as they collect them as a result of their own effort. It is important that the curriculum should give children continuous opportunities to learn processes within a wide variety of subject matter and conditions if these skills are generally to be useful. Because of their physical and mental involvement, processing of data improves thinking skills of students. Hence, they must observe the phenomenon, classify objects, communicate with teachers and classmates, measure objects, plan and conduct investigations and make inferences in order to develop understanding of the subject matter as well as to develop science process skills. Thus, an effective curriculum provides chances to teach process skills within all topics at all grade levels.

There is an urgent need to improve teacher education programmes, particularly the pre-service education of teachers, and the assessment system. Both of these systems must be brought into line with the true nature of science. There is a need to develop awareness in teachers regarding the importance of these skills. And more importantly, if they need to incorporate process aspects of science in the teaching of science, then they need some practical help. It is imperative for them to understand the nature of each process, to identify these skills, to understand where they overlap, how they are inter-related and to decide in what part of the activity children are using a
particular skill or process. As Harlen (1983) puts it, teachers need to develop expertise in assessing the development of these skills by their students. There is a relationship between teaching and assessing. If teachers do not have the skills to assess students' achievement in terms of science processes the utility of teaching these skills will be lost. This then means that there is a need to include all these aspects in the pre-service education of science teachers. By way of implication, it is also necessary that the curricula of pre-service education of teachers needs thorough scrutiny and revision. Traditional teacher education curricula do not cater for this aspect of science. Unless this is done on a priority basis, the objective of the development of science processes, and thus the development of understanding of science concepts, will not be achieved. Science teaching in the classroom will remain traditional, bookish and product oriented, leading to lower understanding in students.

References

International Networking in Science Education at the ASE 1999 Annual Meeting
University of Reading
4 - 9 January 1999

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The science world view among Japanese people: their conceptions of the nature of science, technology and society

Yoshisuke Kumano
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It is predicted that Japanese students may not possess clear images or frameworks concerning the relationship between science and technology in the context of society. This is simply because most of the high school science classes are taught using didactic methods within the framework of an outdated paradigm of science. In this study, using a questionnaire, the views of 2478 Japanese students or adults, concerning the nature of science, technology and society were examined. Interesting results were found and discussed within the context of Japanese culture.

Introduction

Japanese science education now is recognizing major problems and limitations within its traditional framework of education. As many countries have identified the need for improving science and technology education, so must Japan. Kumano (1993) analyzed the status of science education in Japan and compared traditional science classes to the classes in the US. Figure 1 indicates the contrasts found (especially, high school science classes for both countries might be easy to fit these explanations in Figure 1).

Figure 1: Contrasts between Japanese Classes and Traditional Classes in the US

<table>
<thead>
<tr>
<th>TRADITIONAL JAPANESE CLASSES</th>
<th>US TRADITIONAL CLASSES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connection and application</td>
<td></td>
</tr>
<tr>
<td>• Few students can relate their studies to their daily lives</td>
<td>• Students see no value and/or use for their studies</td>
</tr>
<tr>
<td>• Few students can see value in their studies for resolving current social problems</td>
<td>• Students see no value in their studies for resolving current social problems</td>
</tr>
<tr>
<td>• Students are required to memorize concepts/information studied</td>
<td>• Students can recite information/concepts studied</td>
</tr>
<tr>
<td>• Few students can see the importance and relevance of scientific concepts with connections to current technology</td>
<td>• Students cannot relate the science they study to any current technological developments</td>
</tr>
</tbody>
</table>

This paper was originally prepared for the 8th IOSTE Symposium, 1996, Edmonton, Canada and edited and modified with the collection of 383 more data.
Creativity

- Students rarely ask questions. Teachers often ignore these questions in order to follow the course outline
- Students rarely ask unique questions that excite their own interests or those of students and/or those of the teacher
- Students and teachers only rarely consider causes and effects except those found in textbooks
- Students decline in their ability to question; the questions they do raise are often ignored because they do not conform to the course outline
- Students rarely ask unique questions
- Students are ineffective in identifying possible cause and effect relationships in specific situations

Attitude

- Students often do not generate ideas but accept ones from teachers and textbooks
- Student interest in science decreases as he/she gets older
- The major interest of students focuses on how to get high marks on science examinations
- Students have few original ideas
- Student interest in science declines at all grade levels with declines increasing as grade levels increase
- Science seems to decrease natural curiosity

Discussion

In Kumano’s studies (1991, 1995), he concludes that we need to reform Japanese science education in the direction of STS (Science, Technology and Society) education utilizing ‘constructivist’ teaching strategies. However, Kumano (1994) identified major difficulties when moving toward STS frameworks and constructivist teachings in Japan. Some of these include:

- Japanese students can not discuss the interactions of Science, Technology and Society very well; poor explanations are given of their own ideas; they have poor observation power and can not conceive of experiments needed;
- Japanese culture is seen to cause difficulties in using the STS approach;
- Entrance examinations make it more difficult to do STS within competitive high schools or colleges; because of the exams, teachers feel a need to follow the precise content within the textbooks; there is a feeling that it is impossible to do STS within a given semester;
- Students are extremely uncomfortable with the STS approach.

As Yager (1991 & 1993) mentions in his study, STS should be applied differently, depending upon the peculiar context of each country. Within each culture, a great effort is needed to develop models and practices for STS as innovation and reform for science classrooms.

For the development of STS instruction with constructivist teaching, we need to find the status of student views of science in Japan as well as their understanding of the relationship between science and technology, and the relationship among science, technology and society. In a pilot study involving 740 students, data were collected and analyzed using the World View Domain Questionnaire developed by Yager et al (1991). Results were presented at the Pacific Science Congress, Beijing, China (Kumano, 1995). In the instrument, there were some sentences which did not fit the context of Japanese culture, so after long discussions with Shizuoka STS teachers and undergraduate students at Shizuoka University the questionnaire was revised (Ono and Kumano,
1995). This revised questionnaire was used with 200 teachers in Shizuoka Prefecture, Japan. There were fourteen questions and each question had four multiple choice responses. The questions were divided into four categories as follows:

1. Nature of Science
   - Nature of scientific rules
   - Meaning of scientific innovation
   - What is science doing?
   - From what activities science will start?
   - Question No. 1, 3

2. Processes in Science
   - Meaning of scientific experiment
   - Reasons why scientific theory is accepted
   - Characteristics of scientific data
   - Scientists’ attitudes towards changing a law
   - Question No. 2, 3, 7, 10, 14

3. Sociology of Science
   - Social responsibility of scientists
   - Social natures needed for scientists
   - Reasons why scientific theory should drop out
   - Contribution of scientists towards society
   - Question No. 4, 8, 11, 15

4. Interrelation among Science, Technology and Society
   - Ethics of science toward scientific theory
   - Differences between science and technology
   - Question No. 5, 12

Results show that more than forty percent of Japanese teachers have not understood the so-called new philosophy of science. Many teachers believe that the nature of science is fixed and static; that under certain circumstances everybody can find exactly the same results with the same processes and materials. The results of this study indicate that the understanding of the relationship between science, technology and society is very limited. Without understanding the nature of science, the depth of understanding of STS is in doubt. Further studies were done, concerning 2095 people (Kumano, 1996) and 383 new data of college students were added in this paper. The number of people by category is indicated in Table 1, with those providing ‘desirable’ answers reported in Tables 2, 3 and 4.

Table 1. The number of people by category

<table>
<thead>
<tr>
<th>Category</th>
<th>Male</th>
<th>Female</th>
<th>Science oriented</th>
<th>Non-science oriented</th>
<th>Neither</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elementary School</td>
<td>54</td>
<td>63</td>
<td>46</td>
<td>40</td>
<td>22</td>
<td>117</td>
</tr>
<tr>
<td>Junior High School</td>
<td>168</td>
<td>145</td>
<td>88</td>
<td>59</td>
<td>128</td>
<td>313</td>
</tr>
<tr>
<td>High School</td>
<td>229</td>
<td>582</td>
<td>299</td>
<td>343</td>
<td>174</td>
<td>822</td>
</tr>
<tr>
<td>College / Grad students</td>
<td>158</td>
<td>282</td>
<td>208</td>
<td>176</td>
<td>48</td>
<td>446</td>
</tr>
<tr>
<td>Science Teachers</td>
<td>98</td>
<td>37</td>
<td>123</td>
<td>67</td>
<td>28</td>
<td>253</td>
</tr>
<tr>
<td>Adults</td>
<td>82</td>
<td>62</td>
<td>51</td>
<td>53</td>
<td>37</td>
<td>144</td>
</tr>
<tr>
<td>New data (College students)</td>
<td>-</td>
<td>-</td>
<td>67</td>
<td>228</td>
<td>85</td>
<td>383</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>789</strong></td>
<td><strong>1171</strong></td>
<td><strong>815</strong></td>
<td><strong>738</strong></td>
<td><strong>437</strong></td>
<td><strong>2478</strong></td>
</tr>
</tbody>
</table>
Table 2: Percentage of desirable answers in Group 1 for the nature of science

<table>
<thead>
<tr>
<th></th>
<th>2</th>
<th>6</th>
<th>9</th>
<th>13</th>
<th>3</th>
<th>7</th>
<th>10</th>
<th>14</th>
<th>4</th>
<th>8</th>
<th>11</th>
<th>15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elementary School</td>
<td>33%</td>
<td>39%</td>
<td>42%</td>
<td>52%</td>
<td>28%</td>
<td>45%</td>
<td>57%</td>
<td>68%</td>
<td>49%</td>
<td>75%</td>
<td>30%</td>
<td>69%</td>
</tr>
<tr>
<td>Junior High (8th Gr)</td>
<td>10%</td>
<td>36%</td>
<td>54%</td>
<td>53%</td>
<td>30%</td>
<td>29%</td>
<td>40%</td>
<td>74%</td>
<td>48%</td>
<td>68%</td>
<td>44%</td>
<td>62%</td>
</tr>
<tr>
<td>Junior College</td>
<td>18%</td>
<td>28%</td>
<td>53%</td>
<td>43%</td>
<td>24%</td>
<td>30%</td>
<td>48%</td>
<td>67%</td>
<td>48%</td>
<td>83%</td>
<td>48%</td>
<td>62%</td>
</tr>
</tbody>
</table>

Table 3: Percentage of desirable answers in Group 2 for the nature of science

<table>
<thead>
<tr>
<th></th>
<th>2</th>
<th>6</th>
<th>9</th>
<th>13</th>
<th>3</th>
<th>7</th>
<th>10</th>
<th>14</th>
<th>4</th>
<th>8</th>
<th>11</th>
<th>15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Junior High (9th Gr)</td>
<td>26%</td>
<td>48%</td>
<td>57%</td>
<td>43%</td>
<td>25%</td>
<td>40%</td>
<td>67%</td>
<td>72%</td>
<td>53%</td>
<td>86%</td>
<td>66%</td>
<td>74%</td>
</tr>
<tr>
<td>High School (10th Gr)</td>
<td>34%</td>
<td>41%</td>
<td>65%</td>
<td>46%</td>
<td>30%</td>
<td>41%</td>
<td>71%</td>
<td>70%</td>
<td>43%</td>
<td>87%</td>
<td>59%</td>
<td>69%</td>
</tr>
<tr>
<td>High School (11th Gr)</td>
<td>24%</td>
<td>39%</td>
<td>67%</td>
<td>48%</td>
<td>26%</td>
<td>46%</td>
<td>63%</td>
<td>76%</td>
<td>36%</td>
<td>85%</td>
<td>58%</td>
<td>73%</td>
</tr>
<tr>
<td>High School (12th Gr)</td>
<td>40%</td>
<td>47%</td>
<td>58%</td>
<td>46%</td>
<td>39%</td>
<td>51%</td>
<td>75%</td>
<td>75%</td>
<td>48%</td>
<td>86%</td>
<td>69%</td>
<td>81%</td>
</tr>
</tbody>
</table>

Table 4: Percentage of desirable answers in Group 3 for the nature of science

<table>
<thead>
<tr>
<th></th>
<th>2</th>
<th>6</th>
<th>9</th>
<th>13</th>
<th>3</th>
<th>7</th>
<th>10</th>
<th>14</th>
<th>4</th>
<th>8</th>
<th>11</th>
<th>15</th>
</tr>
</thead>
<tbody>
<tr>
<td>College (New Data)</td>
<td>46%</td>
<td>52%</td>
<td>66%</td>
<td>42%</td>
<td>27%</td>
<td>54%</td>
<td>81%</td>
<td>56%</td>
<td>46%</td>
<td>93%</td>
<td>79%</td>
<td>85%</td>
</tr>
<tr>
<td>College</td>
<td>55%</td>
<td>62%</td>
<td>66%</td>
<td>44%</td>
<td>38%</td>
<td>56%</td>
<td>82%</td>
<td>71%</td>
<td>46%</td>
<td>89%</td>
<td>83%</td>
<td>78%</td>
</tr>
<tr>
<td>Science Teachers</td>
<td>53%</td>
<td>61%</td>
<td>60%</td>
<td>48%</td>
<td>38%</td>
<td>59%</td>
<td>81%</td>
<td>65%</td>
<td>59%</td>
<td>95%</td>
<td>81%</td>
<td>92%</td>
</tr>
<tr>
<td>Adults</td>
<td>37%</td>
<td>56%</td>
<td>58%</td>
<td>27%</td>
<td>30%</td>
<td>45%</td>
<td>72%</td>
<td>74%</td>
<td>40%</td>
<td>90%</td>
<td>72%</td>
<td>90%</td>
</tr>
</tbody>
</table>

Table 5 shows the matrix of Pearson correlation coefficients among all the groups. From the Pearson correlation coefficients it is clear that there are great similarities among most of the groups. Also it is possible to identify the three groups given in Tables 2, 3 and 4 above; group 1 (6th grade, 8th grade and Junior College), group 2 (9th grade, 10th grade, 11th grade and 12th grade) and group 3 (college students, college students of new data, science teachers and adults).

Table 5: Matrix of Pearson Correlation Coefficients among groups

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Elementary School</td>
<td>0.782</td>
<td></td>
<td></td>
<td>0.874</td>
<td></td>
<td>0.935</td>
<td>0.958</td>
<td>0.935</td>
<td>0.875</td>
<td></td>
</tr>
<tr>
<td>Junior High (8th Grade)</td>
<td>0.773</td>
<td>0.822</td>
<td></td>
<td>0.874</td>
<td>0.935</td>
<td>0.958</td>
<td>0.935</td>
<td>0.958</td>
<td>0.875</td>
<td></td>
</tr>
<tr>
<td>High School (10th Grade)</td>
<td>0.779</td>
<td>0.778</td>
<td>0.949</td>
<td></td>
<td>0.874</td>
<td>0.935</td>
<td>0.958</td>
<td>0.958</td>
<td>0.875</td>
<td></td>
</tr>
<tr>
<td>High School (11th Grade)</td>
<td>0.790</td>
<td>0.846</td>
<td>0.928</td>
<td>0.968</td>
<td></td>
<td>0.874</td>
<td>0.935</td>
<td>0.958</td>
<td>0.875</td>
<td></td>
</tr>
<tr>
<td>High School (12th Grade)</td>
<td>0.768</td>
<td>0.724</td>
<td>0.953</td>
<td>0.932</td>
<td>0.932</td>
<td></td>
<td>0.874</td>
<td>0.935</td>
<td>0.875</td>
<td></td>
</tr>
<tr>
<td>Junior College</td>
<td>0.835</td>
<td>0.920</td>
<td>0.931</td>
<td>0.924</td>
<td>0.923</td>
<td>0.875</td>
<td></td>
<td>0.874</td>
<td>0.935</td>
<td></td>
</tr>
<tr>
<td>College (New Data)</td>
<td>0.576</td>
<td>0.487</td>
<td>0.868</td>
<td>0.876</td>
<td>0.818</td>
<td>0.903</td>
<td>0.721</td>
<td></td>
<td>0.935</td>
<td></td>
</tr>
<tr>
<td>College</td>
<td>0.520</td>
<td>0.465</td>
<td>0.858</td>
<td>0.868</td>
<td>0.810</td>
<td>0.907</td>
<td>0.681</td>
<td>0.954</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Science Teachers</td>
<td>0.640</td>
<td>0.514</td>
<td>0.889</td>
<td>0.841</td>
<td>0.782</td>
<td>0.917</td>
<td>0.929</td>
<td>0.970</td>
<td>0.929</td>
<td></td>
</tr>
<tr>
<td>Adults</td>
<td>0.659</td>
<td>0.622</td>
<td>0.913</td>
<td>0.885</td>
<td>0.861</td>
<td>0.953</td>
<td>0.776</td>
<td>0.913</td>
<td>0.941</td>
<td>0.936</td>
</tr>
</tbody>
</table>
Conclusion

From all the data above, there are clear characteristics and tendencies, including the following:

1. There are great similarities over the entire population regardless of the age, sex and geography of each population if the population is older than high school or junior college. However, three groups are identified and the older population has slightly higher scores than the younger population, but statistically speaking there is not any significant difference.

2. Percentages of desired responses for the nature of science (average score of four questions out of fourteen) has lowest score among all of the contents. (Nature of science is not commonly well understood; it is expected that realism or experimentalism is still in the main position of science education area in Japan.)

3. For most of the population, social aspects of science and technology (application of science, advancement of technology, ethics of scientists or technologists and social responsibilities of scientists and technologists) are major concerns, as well as future function of scientists.

These results are not surprising at all since there has been so little information available and studies conducted concerning the nature of science throughout all forms of education in Japan – kindergarten to university. In order to harmonize with other countries, major efforts in terms of reform of science education are needed in many portions of education, especially science and technology education in Japan.

Implications for science education

The area of the nature of science has its own contexts and contents, however. The way of learning the nature of science should not be done within the framework of traditional classroom learning, but within the context of an STS approach where each student is encouraged to develop his or her own scientific world view. For every unit in science, it is highly possible to develop discussion time, for example asking, “What is science?” or “What kind of influence does this science have for technology or society?” It is obvious that discussion time for the nature of science does help the reform of science education, but we need more systematic reform strategies for the reality of reform of science education, such as the National Science Education Standards (1996). Consideration of the nature of science could be a good start and a needed step for the early stage of reform of science education in any country in this century.

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Practicable taxonomy of basic skills of science practicals at secondary level for their assessment

R.S. Sindhu and Reeta Sharma
Regional Institute of Education
Bhopal – 462 013 (India).

A new taxonomy of basic skills of science practicals has been recommended for its use in the assessment of students of secondary level (approximately 15 year olds). The taxonomy includes the skills which take into account all the three domains of learning in the holistic perspective. A scheme of assessment based on the taxonomy also has been suggested. The scheme involves the evaluation of students through laboratory practical examination, observational assessment, viva and written record of full academic session. Some of the practicals which help develop these skills have also been recommended.

Introduction

One of the main emphases in science nowadays is its practical orientation brought about by new aims in science education which emphasise science as a process. This leads to the understanding of certain aspects of the nature of science, intellectual and conceptual development, positive attitudes towards science and certain problem solving and psychomotor skills. The importance of practical work in science warrants attention to finding out a valid, reliable and practicable assessment system that can test practical skills. However, practical assessment is not an easy task and doubts persist about its reliability, validity and practicability (Welford, 1990). There are three main technical difficulties which contribute to the problem of practical assessment. First is that there is no practicable taxonomy of practical skills which can be used in the assessment scheme. Several workers (Klopf, 1971; California, 1970; Minnesota, 1977; Ben-Zvi et al, 1977; Tamer, 1978; Doran, 1978; Ganiel and Holstein, 1982; Murphy and Gott, 1984) have made efforts to isolate and define domains of practical skills. However, in some cases these classifications are insufficiently defined and too many skills have been specified in too fine detail so that these can not be assessed in a practical class (Gott et al, 1988). Second, no fool-proof scheme of assessment of practical skills is available at present. Four schemes given so far are: written reports, test items, laboratory practical examination and observational assessment. However, these have been repeatedly criticised on technical grounds (Nuttall and Goldstein, 1986; Johnson, 1989). Third is the lack of defined practical skills at different levels, although some efforts have been made in this direction (DES, 1989; Sibanda, 1990).

The present work deals with the framing of a new practicable taxonomy of basic practical skills to be achieved by students at the age of fifteen (secondary level) and a scheme of assessment, which together address the problems related to assessment of practical skills developed in the students.

Recommended taxonomy of basic practical skills

A number of ways of classification have been suggested for isolating and defining the basic skills. Hofstein et al (1976) identified three practical domains which cover all basic skills as: (i) skill in the performance of routine laboratory tasks, (ii) ability to make observations, (iii) problem solving ability. Ben-Zvi et al (1977) have further divided the third domain into (i) planning and designing of investigations, (ii) performance of experiments, (iii)
analysis, application and explanation. Murphy and Gott (1984) have emphasised only the problem solving aspect of practical skills. Another taxonomy has been given by Kempa and Ward (1975) and Lunetta and Tamir (1978). This is: (i) planning and design, (ii) performance, (iii) analysis and interpretation, (iv) application. Sibanda (1990) has suggested the skills of (i) observation, (ii) recording of data, (iii) analysis of results of experimental work.

However, these classifications are either too thin or too thick to make the assessment of skills a practicably viable exercise. At secondary level, the introduction of skills such as the application of laboratory experiences for new situations is highly ambitious. Therefore, there is a need for framing a taxonomy which is simple in application and is suitable for secondary level. Here, a taxonomy that meets the above requirements is recommended:

1. Skill in setting up the apparatus.
2. Skill in handling the apparatus/specimen.
3. Skill in making observations.
4. Skill in recording the data.
5. Skill in analysis of data/doing calculations.
7. Skill in taking safety measures.

<table>
<thead>
<tr>
<th>Basic skills</th>
<th>Mode of assessment</th>
<th>Break-up of marks (Total marks = 25)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Skill in setting up the apparatus</td>
<td>(a) Observational, during practical examination</td>
<td>a = 2</td>
</tr>
<tr>
<td></td>
<td>(b) Viva, during examination</td>
<td>b = 1/2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 Skill in handling the apparatus</td>
<td>(a) Observational, during practical examination</td>
<td>a = 2</td>
</tr>
<tr>
<td></td>
<td>(b) Viva, during examination</td>
<td>b = 1/2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 Skill in making observations</td>
<td>(a) Observational, during practical examination</td>
<td>a = 4</td>
</tr>
<tr>
<td></td>
<td>(b) Viva, during practical examination</td>
<td>b = 1/2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 Skill in recording the data</td>
<td>(a) Observational, during practical examination</td>
<td>a = 2</td>
</tr>
<tr>
<td></td>
<td>(b) Viva, during practical examination</td>
<td>b = 1/2</td>
</tr>
<tr>
<td></td>
<td>(c) Practical record through continuous assessment</td>
<td>c = 3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 Skill in analysis of data/doing calculations</td>
<td>(a) Observational, during practical examination</td>
<td>a = 2</td>
</tr>
<tr>
<td></td>
<td>(b) Viva, during practical examination</td>
<td>b = 1/2</td>
</tr>
<tr>
<td></td>
<td>(c) Practical record through continuous assessment</td>
<td>c = 3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 Skill in drawing inferences/conclusions/results</td>
<td>(a) Practical examination</td>
<td>a = 3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 Skill in taking safety measures</td>
<td>(a) Observational, during practical examination</td>
<td>a = 1</td>
</tr>
<tr>
<td></td>
<td>(b) Viva, during practical examination</td>
<td>b = 1/2</td>
</tr>
</tbody>
</table>
The meaning of each skill is clear in itself, and does not need any elaboration. Some of the skills which overlap or envelope other skills in scope have been combined together to make the assessment scheme much simpler. The different skills mentioned above take into account all the three domains of learning, i.e. cognitive, affective and psychomotor in the holistic perspective.

<table>
<thead>
<tr>
<th>Name of exercise</th>
<th>Skills involved</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Find out the percentage of water content in a given sample of fresh plant whose weight is given.</td>
<td>Setting up of the apparatus, handling of the apparatus, making observations, recording data, analysis / calculations, results, safety measures.</td>
</tr>
<tr>
<td>2 Study the sample of curd for micro-organisms by making a temporary stained slide.</td>
<td>Setting up and handling of apparatus, observations, analysis, conclusions.</td>
</tr>
<tr>
<td>3 Calculate the solubility of salt / sugar in grams/litre.</td>
<td>Setting up of apparatus, handling of apparatus, making observations, recording of data, calculations, results, safety measures.</td>
</tr>
<tr>
<td>4 Dissolve common salt, chalk dust and milk in water. Classify the mixtures into solution, suspension and colloid.</td>
<td>Setting up of apparatus, making observations, analysis, inferences.</td>
</tr>
<tr>
<td>5 Use thermometer to find out the temperature of the atmosphere after every six hours. Which time has the maximum / minimum temperature?</td>
<td>Setting up of the apparatus, making observations, recording data, conclusion.</td>
</tr>
<tr>
<td>6 Measure the room temperature of four different substances and then put them in the sun for ten minutes and arrange the substances in descending order of their temperatures.</td>
<td>Setting up of the apparatus, making observations, recording of data, analysis, conclusion.</td>
</tr>
</tbody>
</table>

Table 2: Exercises for the development of basic practical skills at secondary level

The assessment scheme recommended above, the most suitable scheme will be a combination of the schemes in a complementary way for comprehensive assessment of these skills. Therefore a laboratory practical examination in which the observational and viva are fused together and practical record assessment is also taken into account for giving marks. However, in the case of practical record only the marks of continuous assessment should be added to the final marks. Thus, for a practical examination of 25 marks, the awarding scheme and mode of assessment are given in Table 1.

The assessment scheme can be applied for measuring the performance of students in different skills by combining the achievements of practical examination and of continuous evaluation of practical record.

Practicals for the development of basic skills at secondary level

Exercises of science practicals during the academic session are given to the students for the development of different types of practical skills. However, it is not necessary that each exercise should lead to the development of all types of skills. But in a holistic model wherein a number of exercises are performed during academic session, these skills should remain in-built and during practical examination two or three exercises which throw light on the acquisition of all the skills laid down for the secondary level should be set. Some of the practicals which lead to the development of different skills are listed in Table 2.

Implications of the present work

The recommended taxonomy of basic skills of practical science at secondary level can be applied to the present ongoing system of examinations by making some variations in the approach of the
examination. The awarding of marks is simple, valid and reliable.

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Location: George Washington University, Washington DC, USA
Contact: Prof. Dr. Michael Dyrenfurth, President, National (USA) Association of Industrial and Technical Teacher Educators, 105 London Hall, Technology & Industry Education, University of Missouri-Columbia, Columbia, MO 65211, USA, fax: +1 573 884 4095, email: <pavtmike@showme.missouri.edu>
The National Association of Industrial and Technical Teacher Educators, the European Society for Technology Education and the World Council of Associations for Technology Education invite you to participate in an international seminar on the theme 'Outcomes of Technology Education for 2000+: A Focus on Learning: Models, Criteria and Demonstrations of Applied Learning and Assessment Methodologies'. The following themes present an opportunity for the seminar participants to structure their remarks: subject centered and/or interdisciplinary orientations for technology education; what are the key outcomes/benefits that result from participation in technology education; which learning and assessment theories are significant with respect to becoming competent in
Calendar

technology teacher education; how can persons with special needs be better served and how can the diversity and inclusiveness of technology education be enhanced. See the website for further information: <http://unesco.uneb.edu/wocate>.

October 16 - 18
Symposium 'Education of Science Teachers'
Location: Nałęczów, Poland
Contact: Jarosław W. Dymara
Department of Chemical Education
Maria Curie Skłodowska University
Pl. M.C. Sklodowska 3
20-031 Lublin, Poland
fax: +48 81 533 36 69
email: jdmara@hermes.umes.lublin.pl

November 5 - 7
Annual Conference of the Science Teachers
Association of Ontario
Location: Toronto
Contact: Jon P McGoe, c/o John Paul II Secondary, 1300 Oxford Street East, London, Ontario N5V4P7
email: jmcgoey@quark.physics.uwo.ca
Information is on the website at <www.stao.org>

November 18 - 22
European Researchers in Didactics of Biology Conference
Location: University of Goteborg, Sweden
Contact: Dr Fred Brinkman, Secretary, IDO Vrije Universiteit, Amsterdam, Netherlands,
email: <fg.brinkman@ido.vu.nl>

1999

January 7 - 9
ASE Annual Meeting
Location: University of Reading, Reading, England
Contact: ASE Annual Meeting, The Association for Science Education, College Lane, Hatfield, Herts AL10 9AA, fax: +44 1707 266 532, email: <ase@asehq.telme.com>
The theme of this meeting is 'Science Education in the Computer Age'.
The Annual Meeting of the Association for Science Education attracts science educators from around the world. Don’t miss the substantial program of plenary addresses, papers, seminars, workshops, visits, displays and functions which makes this event one of the largest international gatherings of science educators. Following on the success of the 1998 ASE-ICASE-IOSTE International Seminar, a similar international seminar is being planned to precede the 1999 ASE Annual Meeting from 4 January.

March
ICASE NVON International Seminar
Location: Netherlands
Contact: Miia Rannikmae, ICASE European Regional Representative, Department of Science Didactics, University of Tartu, Lai 40 Tartu EE 2400, Estonia, fax: +372 7 465 813
email: <miia@queenie.lai.ut.ee>

March 25 - 28
NSTA National Convention
Location: Boston, Massachusetts, USA
Contact: NSTA Conventions Department, 1840 Wilson Blvd, Arlington, VA 22201-3000
email: <conventions@nsta.org>.
Join science educators from across the USA and around the world in a huge program catering to the needs of elementary/primary and secondary teachers of science and tertiary science educators. See the website for further information:

July 10 - 16
9th IOSTE Symposium
Location: Durban, South Africa
'Science and Technology Education for Sustainable Development in Changing and Diverse Societies and Environments'
Contact: Mr Alan Pillay, Chairperson IOSTE 9
Faculty of Education, University of Durban-Westville Private bag X54001, Durban 4000, South Africa
Fax: +27 31 204 4866
Email: spillay@pixie.udw.ac.za

September 15 - 19
5th International HPSST Conference
Location: Pavia University, Italy
Contact: Dr Enrico Antonio Giannetto, Dipartimento di Fisica ‘A Volta’, Universita di Pavia, Via A. Bassi 6, 27100 Pavia, Italy, email: <volta99@pv.infn.it>.
This conference is being held in conjunction with the European Physical Society’s Interdivisional Group on History of Physics and Physics Teaching. The joint conference will contribute to local celebrations of the bicentenary of Alessandro Volta’s creation of the battery at Pavia University in 1799. See the website for more information: <http://www.cilea.it/volta99>.
Calendar

October 4 - 8
3rd ICASE Latin American Symposium
Location: Curitiba - Parana State, Federal University of Parana, Brazil
Contact: Department of Educational Methods, School of Education, Federal University of Parana, Rue General Carneiro, 460 2o. Andar, Curitiba - Parana, CEP 80 060 - 150, Brazil.
Phone / fax: + 55 41 264 3574
Email: gioppoc@educacao.ufpr.br

The 3rd ICASE Latin American Symposium will be hosted by the Brazilian Association for the Advancement of Science - Parana Section, and will attract science educators from across the Latin American region and beyond.

2000

April 6 - 9
NSTA National Convention
Location: Orlando, Florida, USA
Contact: NSTA Conventions Department, 1840 Wilson Blvd, Arlington, VA 22201-3000,
e-mail: <conventions@nsta.org>.

July 19 - 21
ICASE-CEFIC European Education-Industry Seminar
Location: University of York, York, UK
Contact: Miia Rannikmae, ICASE European Regional Representative, Department of Science Didactics, University of Tartu, Lai 40 Tartu EE 2400, Estonia, fax: +372 7 465 813,
e-mail: <miia@queenie.lai.ut.ee>.

Science Across the World makes its website

A working example of how the Internet can bridge language and cultural differences has been given a facelift after two years in the field and a rising popularity among schoolchildren in 46 countries.

The Science Across the World programme, coordinated by the Association for Science Education in Britain, was one of the first to incorporate a website into an education programme. The programme aims to raise awareness of science and technology issues in society, industry and the environment. The Internet was used initially to allow teachers and students to send information to other schools.

But there is much more to the new site. It is easier to navigate and more visually appealing. Ease of navigation and speed of download are key features. There are no spinning logos: instead there are resource areas, with discussion forums and news sections to contribute to. Nor is it all dull text. Video clips are available. And the whole thing is available in six languages - English, French, German, Italian, Portuguese and Spanish.

Those who dream of using the Internet in schools might like to check how its done in Science Across the World. There are 1 200 schools worldwide using the BP-sponsored programme, and in the last six years it embraces schools in Africa, the AsiaPacific region, Europe and North and South America.

http://www.bp.com/saw
Extending and improving education in science for all children and youth by assisting member associations throughout the world

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Science Education International is the quarterly journal of the International Council of Associations for Science Education. ICASE was established in 1973 to extend and improve education in science for all children and youth by assisting member associations throughout the world.

This journal provides a means for associations, institutions, centres, foundations, companies and individuals concerned with science education, to share perspectives, concerns, ideas, and information which will foster cooperative efforts to improve science education, and which will serve as a chronicle of the advancement of science education throughout the world.

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A National Workshop about Science and Technological Education in the Environment "Taller Nacional Sobre Educacion Cientifica, Tecnologica y Ambiental Mar del Plata."

UNESCO, ICASE, Club de Ciencias "Albert Einstein", Ministry of Ed. Argentina

Argentina's history created a legacy of weakness at the human resource level of education. The desired changes that have come to light with the democratic government are not always easy to implement. People lack experience in discussing society-related topics. Group work, workshops and creative discussions are essential in order to redress this situation. A new curriculum has been written which allows regional and interdisciplinary approaches. Ten out of twenty-four Argentinian provinces have taken up the new curriculum and are setting their own parameters. Other provinces are more dictatorial, and some are more modern than others. Different standards and varying strategies are needed to combat the inequalities that exist today. Science related to Argentina must be a major parameter. Values, attitudes and social concepts must be taken into account. However, a contradictory situation exists as societal issues like health, consumers and the environment are areas that cross the boundaries of the subject disciplines. The training of many teachers has been in disciplines and not areas.

There is an urgent challenge to make the curriculum content significant. Curriculum and teacher changes have to be put in place in an order appropriate to the context. The differences within the country need to be respected. Technical capacity is not available everywhere and working conditions vary from province to province. The new basic science curriculum aims at allowing such flexibility. Implementing change is always a hard task. Teachers must be involved in the innovations and feel ownership of them.

The Argentina National Workshop for Science and Technological Education in the Environment - "Taller Nacional Sobre Educacion Cientifica, Tecnologica y Ambiental", was held in Mar del Plata in June 1998. This workshop was part of the National Programme for development of materials for Scientific and Technological Literacy for All. Jack Holbrook of ICASE led the workshop, which was sponsored by the

Presentation to Marta Moyano, organiser of the Argentinian STL Workshop and ICASE Latin American Representative
Ministry of Culture and Education. Laura Fumagalli represented the Ministry and set the scene for the event. The workshop was brilliantly organised by the ICASE regional representative, Marta Moyano of the Einstein Science Club in Mar del Plata. The programme was honoured by contributions from Orlando Rose Hall, Beatriz Macedo of UNESCO. Anna Garner, President of ICASE, also spoke.

The workshop gave teachers from all the provinces of Argentina, along with representatives from Bolivia, Brazil, Cuba, Paraguay and Uruguay, the opportunity to meet in groups for discussion and to create meaningful science teaching materials. Twenty-four papers and materials were created during the week. The created scripts are in context with the new central ideas and also reflect the teachers’ own local and cultural areas. The ‘ownership’ and ‘attachment’ of the teachers to their created materials is the best way to ensure their use in the classroom. This is perhaps one of the greatest strengths and values of workshops such as this. Hopefully each representative will now go on to encourage such workshops in their own provinces or countries. This will help the “alphabetization of science”, and reflect the aims of Project 2000+ in meeting the demands of society and the citizens.

The role of the teachers must be to guide and develop a new style of science in schools. Argentinian teachers have a good attitude and want to teach well. Without exception the participants of this workshop, were enthusiastic, open to new ideas, honest and open in discussion, and above all dedicated to better science teaching. It was a refreshing contrast to see the dynamic nature of discussions and the enthusiasm when working together. Opportunity for discussion is sometimes taken for granted in countries with a longer tradition of democracy.

Changes in Science education in Argentina are just starting. The spirit of Project 2000+ for teaching science within the societal context is certainly alive and growing in Argentina. I hope similar progress can be made in other countries of South America. This workshop was certainly excellent.

Congratulations go to the organizers of this very successful event.

**VAEST**  School science and the future of scientific culture in Europe. An EU Project also supported by industry

The original project of this name collected national reports on science education from fourteen European countries, and analysed them for features that would enhance popular scientific culture. A follow up project initiated by Dr Joan Solomon of the Open University UK, is the launch of the Virtual Association of European Science Teachers (VAEST).

VAEST is an opportunity to link all those involved in science education - informal and formal - and scientists across Europe using computer links.

The Launch Meeting of VAEST was held in Portugal June 27-29 1998. Countries with early involvement in the project, Portugal, Greece, Sweden and the UK, were well represented at the successful launch, as were Denmark, France, Germany, Iceland, Italy, Norway and Poland.


Anyone in Europe can join VAEST, at the present time for no cost, thanks to funding from the EU, Esso and BT. For more information look on the internet at [http://watt.open.ac.uk/VAEST](http://watt.open.ac.uk/VAEST). The four main communication groups currently established are Astronomy, Global Bioethics, Greenhouse Effect and sustainability and Perception. If you would like join a group, say what you are doing, say what went well in science teaching or contribute teaching materials or information to the resource pool these will be most welcome. The links can be hot lines for questions, provide a share centre for useful website addresses and become a resource pool in several languages. A CD-ROM of teaching materials is also being produced.

VAEST is a welcome member of ICASE and is a useful medium for individuals. We hope that many of the useful ideas shared among individuals in VAEST will also be brought to the Science Teacher Associations and so shared on a Europe-wide network.

Anna Garner
ICASE President
ICASE Continues to Promote Project 2000+ Workshops

ICASE has been involved in promoting its STL (Scientific and Technological Literacy for All) philosophy to its member organizations by running workshops for the creation of STL teaching materials. Following the publication of the book on Supplementary Teaching Materials (ICASE 1997), ICASE has been involved in running regional workshops in Europe, Africa, Asia and Latin America.

Second National STL Workshop (Argentina)

This year has seen Science Teachers’ Associations (STAs) interested in holding national workshops. The first was held in Nepal in March (see June issue of SEI). The second National workshop was held in Argentina (Mar del Plata, 8-12 June 1998) and is described in the President’s Report above. It was a very successful workshop and in total 24 scripts were created in Spanish. These are now being edited ready for piloting in schools. After modification, ICASE hopes to publish these materials on the internet.

The success of this workshop is in no small way due to the efforts of the ICASE Latin American representative, Marta Moyano and the team of people from the ICASE member organisations in Mar del Plata - Club de Ciencias “Albert Einstein”. Thanks also goes to the Ministry of Education in Argentina and to the UNESCO Regional Office for Latin America for their participation and support.

Third National STL Workshop in Hong Kong

The third national workshop on the creation of STL teaching materials was held in Hong Kong (22-26 June 1998). This was held under the auspices of the Hong Kong Association for Science and Mathematics Education and the University of Hong Kong. The 1st morning was a short symposium on STL so that the concept could be spread to a wider audience than could attend the workshop. The rest of the week was a workshop for 25 participants following the standard pattern but this time more attention was put into evaluating the achievements of the workshop in the eyes of the participants. Participants also incorporated criteria referencing assessment ideas into their scripts in line with the pattern established in the book on Supplementary Teaching Materials.

An evaluation activity on the last day involved participants putting forward, as individuals, their ideas on what the workshop had tried to achieve, then collectively in groups determining the main features of the workshop and finally collecting all these to create a list of ideas promoted. This will provide valuable information for future workshops.

There were observers at the workshop from Beijing and Shanghai as it is hoped to follow up the success of this workshop by running similar ones in these cities, possibly using some of the participants as resource persons. Whilst this workshop was held in English, the ones in Shanghai and Beijing are being planned in Chinese (Putonghua).

The success of this workshop was very much due to the efforts and energy of Or Choi Kuen, the main organizer in Hong Kong. Thanks go to the University of Hong Kong for the use of its excellent facilities (would you believe the presentations on the last day were by using an LCD projector linked to a computer using Power Point software), the HKASME for its support and to the Curriculum...
The photos on this and the opposite page show participants in the Scientific and Technological Literacy for All Workshop in Hong Kong. (June 1998.)
Development Institute of the Department of Education for ensuring teachers were able to participate and for their interest in this workshop. ICASE was represented by three resource persons, the secretary, Mia Rannikmae, the European representative and Robin Groves, the ICASE journal editor, who was able to inject new ideas into the presentation. Filocha Haslam from Australia was also a very valuable resource person. It is hoped the material from the workshop will be put on the internet and also translated into Chinese to be used as exemplars for the national workshops in Beijing and Shanghai.

A European Regional STL Workshop

UNESCO contracted ASE, the ICASE member organization for science teachers in the UK, to run a European regional workshop in London (June 1-5). Participants in this workshop came from ICASE member organizations in Belgium, Netherlands, Ireland, Iceland, Sweden and Finland. ICASE itself was represented by the ICASE European representative, the secretary, treasurer and two support persons, Norman Lowe and Dennis Chisman.

No teaching materials were developed by the participants but the criteria for these were firmly established based on the ICASE philosophy for STL. Much discussion centred around the STL philosophy and how it can be incorporated into the work of STAs in Western Europe.

Follow up involved giving ideas of materials to be developed and then piloting in each of the countries represented. Consideration was given to follow-up national workshops in each of the participating countries with the representatives present as the major resource persons. Thanks go to the ASE for organising this event under the sponsorship of UNESCO and especially to the hardworking team of Caroline McGrath, David Sang and Marianne Cutler.

a new Rusnet, a planned internet for Russians. ICASE looks forward to greater cooperation with St Petersburg and Russia in the future and hopes it becomes possible to run a national workshop next year with the help of Herzen University’s Department of In-service Education.

During the visit the ICASE Secretary and European Representative were able to visit a school in St. Petersburg and hold interesting discussions with a very distinguished chemistry teacher who had instigated many developments in the school supporting experimental work, creating visual aids and ways to make posters and charts more visible to the students and building up a school science museum.

Other National STL Workshops?

ICASE encourages STAs to follow up the STL philosophy developed by ICASE and make teachers more aware of these developments. A national workshop is an excellent way to do this. The current model, proving successful, is a five day workshop in which participants are involved in taking ownership of the idea by creating STL teaching materials.

ICASE is very willing to assist and make resources available if possible.

As a further follow-up ICASE is pioneering an ICASE-UNESCO Certificate to recognise teachers promoting STL. This certificate is designed in such a way that it can be administered and awarded by the local STA. For further details and expressions of interest for national STL workshops, or for the STL Certificates, please contact the ICASE secretary.

Jack Holbrook
ICASE secretary

STL Seminar in St Petersburg, Russia

The ICASE Secretary and European Representative were invited to give a seminar on STL to about 40 chemistry teachers in St Petersburg in May 1998. The teachers expressed much interest in the STL idea and were eager to try out materials once they had been translated into Russian. Thanks go to Andrei Zhegin and Herzen University for making the visit possible and for their interest in translating STL material into Russian with a view to putting these on
Feature Article

Teachers, teaching strategies and culture

Glen Aikenhead, Saskatchewan University, Canada

A Science Education Parable

"If the law of gravity is universal, then what is the force of attraction between two neutrons in a nucleus?" an inquisitive student asked.

"No, don't think about gravity in the nucleus," answered the teacher, "because strong and weak forces hold neutrons and protons together in the nucleus."

Teaching

Teaching is not a theoretical act that has universal application, but a very practical act that takes place in specific classrooms with unique students. Teachers may draw upon theories of instruction as inspiration in an eclectic way, but success in the classroom depends on the decisions that teachers make based on their practical knowledge about teaching. Therefore, the topic 'teaching strategies' must not be taken out of context and treated as a universal to follow. Instead, 'teaching strategies' must be contextualized as one part of a teacher's practical knowledge about instruction.

Research into this practical knowledge sheds light on some of its complexity (Duffee & Aikenhead, 1992). Decisions about what teaching strategies to use are invariably filtered through a teacher's image of a good teacher. Dilemmas arise when this image cannot be maintained, and stress results have accumulated through past experiences. Decisions are strongly influenced by practical principles (rationales for action). Practical principles are related to the goals of teaching in the current situation, and involve reflection over the choices and constraints at hand. Decisions are also contextualized by the teacher's students, colleagues, school administration, physical and material environment, community, and legislation. The choice of what teaching strategy to use is potentially a very complex decision.

On the other hand, teaching can be seen as an act of cultural transmission (Spindler, 1987). The conventions of culture can greatly simplify choices that teachers make. For instance, the assignment to read and memorize the language of science is a cultural convention in many countries where thin walls between resource-poor classrooms of 70 or more students require silence because the teachers in the adjacent classrooms should not be disturbed. Instructional innovations (such as requiring students to interact) that are developed in more affluent countries may seem foreign to the culture of the less affluent school. Interactive teaching strategies, therefore, cannot be misconstrued as being universals for teaching science.

The conventions of culture can also explain why changing teaching strategies involves more than technical training to manage, for example, interactive
students. Reforming teaching strategies certainly causes changes in the microculture of a classroom which is embedded in a microculture of a school which in turn is a living social icon of the culture of the community or nation. Jegede (1994) clarifies a problem found in African nations where the conventional respect for authority contradicts the scientific ‘habit of mind’ of questioning current explanations about nature. Another teaching strategy associated with science education reform is inquiry. Scientific inquiry harbors values belonging to the culture of Western science. These values may be perceived as inappropriate for some classrooms. Rampal (1994) describes the tension and fear that ensued after inquiry was successfully introduced into a school in India. Even when this scientific inquiry solved a local puzzle for the community, students had to learn to cope with the community’s backlash. My point is not to dismiss inquiry or other teaching strategies associated with reform. Rather, my point is that we need to recognize that teaching strategies must be discussed in the cultural context of culture transmission in a particular school.

A technical rational ideology (prevailing in many education systems in Western industrialized countries) isolates teaching strategies from their context of culture. Teachers are assumed to be educational technicians. Science education standards developed in such countries need to be scrutinized for their ideologies, the technical rational ideology and others (Fourrez, 1989).

Science education worldwide is not culture-free, of course, and ideologies enrich every country’s expectations of schools. Teaching strategies are, in part, expressions of those expectations. Therefore, if we are to reform science teaching in classrooms, we must also reform those ideologies that inhibit reform, ideologies that are subtly framed within the social structure of schools (the ‘hidden curriculum’). For example, some teaching strategies (a student-centred discussion of a local health issue, for instance) may only be successful when the hierarchical authority relationship between teacher and student is modified. But cultural conventions may sustain a teacher’s image of good teaching, and may sustain a fundamental ideology of the community and country. Science education reform, if taken seriously, is ideological reform. Schools, not just science classes, will have to be reformed accordingly. This is the cultural reality that reform must acknowledge.

Research

Reform in science education has been studied in terms of movements such as science-technology-society (STS), environmental education, and scientific literacy, all of which call for teaching strategies that actively involve students, for example, in divergent thinking, small group work, student-centered class discussion, community problem solving, simulations, decision making controversesies, debating and using the media and other community resources (Aikenhead, 1988; Holbrook & Aikenhead, 1997; Solomon & Aikenhead, 1994; Yager, 1992a, 1992b). Research into teaching strategies, conducted in both developed and developing countries, invariably shows improvement in student learning associated with most outcomes of reform efforts, without diminishing the average success on traditional science content examinations. In Byrne and Johnstone’s (1988) review of research, they concluded:

1. In terms of learning science content, simulations and educational games can be just as effective as traditional methods. In terms of developing positive attitudes, simulations and games can be far more effective than traditional methods.

2. In terms of attitude development, the strategies of role playing, discussion and decision making can be highly effective; but the essential ingredient is the achievement of interactivity, rather than the exact format, whether it be simulation, group discussion or role playing, which is central to attitude development (p. 44).

3. “Group discussion can stimulate thought and interest and develop greater commitment on the part of the student” (p. 45).

4. In terms of promoting an understanding of the processes of science, an analysis and evaluation of historical case studies is effective.

Making concrete connections between the content studied in class and the students’ everyday world piques student motivation, commitment and a personal responsibility towards learning.

Some excellent research has taken place in developing countries by people exploring the consequences of introducing interactive teaching strategies that relate school content with the students’ everyday world. In Nepal, for example, a researcher introduced a strategy he called ‘a narrative approach’ that focused on questions such as: Can snakes really
retain the visual memory of those who harm them? or Crows don’t die a natural death, do they, sir? (Brajacharya and Brouwer, 1997, p. 436). These class discussions had the same results as found in the research summarized above. Moreover, the cultural disruptions caused by the innovations were also researched. The teaching strategy apparently has promise: “Its greatest strength seems to be that a story-telling, or story-sharing, mode of teaching can be introduced into the classroom in a very natural, unobtrusive way, without interfering with the traditional goals of science teaching” (p.445). The collaborating teachers were not as successful in their first try as the participant researcher was. However, one finding (only mentioned in passing in the research report) has significant implications to the discussion above on cultures and ideologies: “the various school administrators in the participating schools were intrigued by the idea of teachers collaborating in addressing some of the pedagogical and curricular problems faced by Nepalese teachers” (p.435). There would seem to be ample opportunity to investigate innovative teaching strategies introduced into cultures that might otherwise seem to be supportive, as long as the teachers are collaborating (action research) and the school’s microculture is part of the study.

Other research on teaching strategies has taken place within the paradigm of cultural anthropology. A cultural perspective on teaching science recognizes teaching as cultural transmission, science as the culture to be transmitted, and students as having their own cultural identities that may or may not correspond to the culture of Western science. For the vast majority of students of any culture, their cultural identities are at odds with the culture of science. For these students (for whom ‘science for all’ is a goal), it was recognized that learning science is a cross-cultural experience. Thus, these students must cross cultural borders (between their own world and the world of Western science) before they can learn science in any meaningful way. The act of cultural border crossing has direct implications for using appropriate teaching strategies.

One set of implications was summarized by Aikenhead (1997):

1. make border crossings explicit for students;
2. facilitate those border crossings;
3. substantiate the validity of students’ personally and culturally constructed ways of knowing;

and

4. teach the knowledge, skills and values of Western science in the context of science’s cultural roles (social, political, economic, etc.).

In order for teachers to accomplish these, they need to put themselves in the role of a culture broker – an agent who guides students from one culture to another (Aikenhead, 1996). A culture broker may act like a travel guide who makes the culture of Western science, for example, the ‘narrative approach’ discussed above. A tour-guide teacher introduces students to another culture by using a high degree of guidance (in keeping with many national cultures). This role is associated with the learning process of acculturation (Aikenhead, 1997).

Alternatively a culture broker may act like a travel agent. A travel agent teacher makes the culture of Western science accessible to the ‘traveller’ students by also using teaching strategies predicated on cross-cultural instruction, but uses a much lower degree of guidance by establishing academic bridges to help students manage their own cultural border crossings into science. This role is associated with the process of ‘anthropological’ learning. The difference between guided tours and academic bridges is a matter of degree, not of kind. Academic bridges will have more academic abstraction, analysis, and self-initiated participation (in keeping with the idea of travel agents arranging passages for clients but travelling along with their clients).

Conclusion

Specific teaching strategies appropriate to the role of culture broker must still be investigated and developed. ‘Culture broker’ is a fairly new idea, but one that can make intuitive sense to teachers. We all can imagine how we would introduce a ‘foreigner’ into our native culture, under the constraints of formal schooling. The idea of culture broker has potential for reformulating teaching strategies to harmonize with a teacher’s practical knowledge and the classroom microculture. Reform must be sensitive to the culture and ideological milieu of instruction. Universals do not work.

References

Aikenhead, G. S. (1988). Teaching science through a science-technology-society-environment approach: An instruction guide. Regina, Canada: University of Regina, SIDRU, Faculty of Education


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**ICASE Distinguished Service Award**

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The Baltic Sea Project
- A network of schools within UNESCO's Associated Schools Project working for environmental awareness, international co-operation, problem solving and finding solutions in order to achieve sustainable development.

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Deserted beach
where everything is grey
and shiny, oily water with no winds
the empty road to the other coasts

Slimy algae choke the bottom
greenish grey and brown,
and there are piles of rotting seaweed
on the beach

Here at life's forgotten place
the clouds stand still
with bowed heads
and black shadow birds
point their sharp beaks
at the barrenness

and the raucous throats
grate on the dry, empty boats of the beach

Ole Sarvig, Denmark

(from "Working for Better Water Quality in the Baltic Region",

Environmental awareness concerning the suffering Baltic Sea and the perception that pollution knows no borders made the starting point for the Baltic Sea Project at a time (1989) where the borders gave limited access and prevented students and teachers from exchanging points of view person to person.
The Baltic Sea has a surplus of water. Salt water from the oceans enters through the narrow Danish straits as the heavier bottom layer and surplus fresh water flows out from the entire drainage area as the surface layer. So in all, the Baltic Sea consists of brackish water with great differences in salinity. The bottom conditions show thresholds preventing the salt water intake, and deep depths in the Baltic proper makes it a very vulnerable sea. The turnover time of salt water has been estimated at 70 years. The Baltic Sea is therefore utterly vulnerable to the impact of human interference, the run off through rivers from different land use and through downfall from the atmosphere.

Within the Baltic Sea Project a joint programme has been elaborated to trace the impact of humans, making a scientific method that can be used in the whole Baltic region. The programme is called Water Quality. A Learners' Guidebook has been published for use within the programme; an educational video has been made to introduce the programme to students, and a computer programme "WaQua" has been made to store the data enabling long term comparisons. Students investigate the presence or absence of certain species on the beach; they measure the numbers of individuals of each species in 1 square metre of the bottom at approximately knee deep waters; they measure redox-cline in the bottom sediment and the amount of organic material; they measure visibility, salinity, oxygen saturation, amount of nutrients such as nitrogen and phosphorus in the water; water samples are taken to examine and determine the amount and constellation of plankton. Often the amount of epiphytes that grow on larger plants or algae can tell that the water is eutrophicated, too enriched with nutrients. By having many schools investigating many different localities around the Baltic Sea and by using the same often simple methods at the same place over and over, the data become comparable. Reports are made to a programme co-ordinator who stores the data in a computer file, and who sends all updated data to participating schools. So the same tests made at the same place can show if conditions have turned better or worse. Data can also be compared with data from other localities in the Baltic region for discussions and understanding of the importance of factors such as salinity, oxygen saturation, amounts of nutrients, redox-cline etc.

In one place, one school might find very high production rates by measuring the (low) visibility in the water bodies and by examining the plankton in the microscope, and they can then search for the possible causes be it sewage not being treated properly, or let outs from industries or agricultural land use, and they may confront the decision makers with their observations and results, and ask what they will do about it. So through participation in the Water Quality programme within the Baltic Sea Project they can use their accurate observations not only to obtain knowledge on the Baltic Sea, but also as a means of active participation in the process of creating a sustainable future.

The Baltic Sea Project took its starting point with the Water Quality programme. But since then a number of programmes have been elaborated: Rivers, Air Quality, Phenological studies, BSP-CoastWatch, Bird ecology, Environmental history - all with a programme co-ordinator (teacher) in charge of getting the protocols and reporting back to active schools. However, new themes develop as sustainability demands teaching a necessary change of lifestyle, and an Agenda for the Baltic Region has taken into environmental education sectors on agriculture, energy, fishery, forestry, industry, tourism, transport, water, health and medicine. These innovative ideas add new perspectives to the Baltic Sea Project, and enable many more teachers teaching a wide variety of subjects to achieve a holistic, interdisciplinary approach.

For further information on the Baltic Sea Project please visit the Internet address:
http://www.b-s-p.org

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Science and technology education at the secondary level in Thailand


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Introduction

This paper emphasises the importance of science and technology education in Thailand which is one of the member states in the APEID network. APEID is the Asia-Pacific Programme of Educational Innovation for Development, which has 199 Associated Centres in 29 countries. There are six associated Centres in Australia. ACEID (the Asia-Pacific Centres of Educational Innovation for Development) is the hub of the APEID and several other networks which UNESCO, Bangkok services.

APEID aims to help member states strengthen their capabilities for creating and using education innovation to solve educational problems. It has paid a lot of attention to the development of science and technology education, sharing appropriate teaching methods and working collaboratively to develop science teaching, learning materials, kits, and equipment in order to strengthen teacher training for science education. Furthermore, as teachers become more competent, given the proper tools and training, they will be able to use their knowledge to control new information technologies and to make use of them in their work and daily lives. Even though most of the countries in the Asia-Pacific region are suffering on account of the economic crisis, every country still recognizes the need for developing its future generations in science and technology, in order to cope with problems which will arise in their future lives.

The Thai Educational System

The Thai educational system provides for six years of primary education, three years of lower secondary education, and three years of upper secondary education. Educational administration is centralised. All schools throughout the country use the same curriculum, authorised by the Ministry of Education. Primary education is compulsory for all children from the age of 6-12. Preparations are being made to extend compulsory education to include lower secondary education. Study at the secondary level is not compulsory but depends on the parents' attitudes, finance and the student's ability. The Ministry of Education is responsible for the provision of primary and secondary education, with the Ministry of University Affairs responsible for tertiary education. Education after the second level is separated into two programmes: the four-year bachelor degree programme and the three-year diploma programme, focused on the training of technicians and skilled workers.

The Department of Educational Techniques within the Ministry of Education is in charge of curriculum
development for primary and secondary schools in all subjects except science and mathematics. In 1972 the Government of Thailand established a semi-autonomous body in the form of a state enterprise with the task of promoting the teaching and learning of science. That organization is the Institute for the Promotion of Teaching Science and Technology (IPST). Many new science curricula have been developed and implemented by IPST.

The revised curriculum is now more technologically oriented. Activities and practical problem solving concerning students' own communities, added to the IPST Science Design Team, have attempted to develop a Thai-oriented modern science programme for Thai students.

**Science Teaching in the Secondary Schools**

There are three levels in the lower secondary education programme and science is a required subject for all students in all grades. The science course offered is an integrated one rather than following separate sciences disciplines.

The lower secondary school science courses are intended to interest, motivate and involve students in understanding science, helping them to identify problems and to look for methods of solving them. All curriculum materials and activities are designed to enable students to observe their environment, enrich their experiences and develop scientific skills. Through science studies, students gain knowledge of scientific facts and principles and have a better understanding of nature and their environment. The practical experience of doing science also develops students' scientific attitudes. As to the emphasis on scientific process skills or relating science to students' daily lives, schools are encouraged to offer more science elective courses. Elective courses should relate to students' interests, such as "Fun with electronics", "Home electrical appliances", etc. Hence, the elective science courses are more locally oriented. Each school can develop its own science course or can select any other science course for its students. It is expected that the study of science and technology will be more locally oriented and will be more relevant and suitable for students' interests, needs and abilities.

In upper secondary education, students who plan to further their education in science or science related fields are guided into taking science discipline courses such as chemistry, biology and physics. Science courses in the upper secondary schools are obligatory for students who want to take up science and science related careers at the university level. Elective courses for upper secondary students allow for students to follow their interests in a wide range of after school activities.

Students who plan to further their education in fields not related to science are required to take Physical and Biological Science (PBS) which is specially designed for these non-science destined students. There are fourteen independent modules. Students are required to study eight modules, in any sequence of four semesters, in three years. The fourteen modules are: Solar Energy, Light, Coloring Matter, Electrical Appliances, Invisible Rays, the Earth and Stars, Synthetic Materials, Sound in Everyday Living Natural Resources and Industry, Good Living, Medicine and Life, Our Body Evolution, Heredity and Environment.

Since the manpower needs in Thailand in the fields of Science and Technology, especially in the areas of material science, computers, electronics, will be very acute during the next decade, the science and mathematics curricula from the primary to upper secondary school will be influenced by that need. It is therefore to be expected that elective courses in new subjects of science, related to technology, will be introduced to provide opportunities for students to develop skills for work and daily life. However, at the upper secondary level, specialised studies in these areas are sometimes directed towards a more vocational orientation, such as electronics, computer science, and user applications.

**Toward developing science and technology education in Thailand**

Science has become a part of our everyday experience, thus it has been made an essential component of the school curriculum at all levels in Thailand. Teaching science realises the potential and scope of science in two basic student activities, which relates to asking questions and solving problems. As such, they constitute an intellectual strategy that every learner should adopt for day-to-day finding, learning, knowing, understanding and doing things in a better way for a better life.

In the past, the science curriculum in Thailand was focused on scientists' work, their method of developing and testing scientific knowledge, concepts and theories that are central to the scientific...
discipline, and understanding some of the methods, concepts and theories that scientists used and applied in our everyday lives. Less effort was made to link this knowledge, these skills and attitudes to a technological application and to the social concerns and the daily experience of the students. In response to the rapid changes in developing science and technology education, the content of science education should be enriched and place greater emphasis on technology that relates to science learning for today and into the future and assists in attaining a better life for all.

IPST has been most active in its efforts to achieve science literacy rather than science being merely a school subject. In Thailand, science curricula had been revised in order to make them compatible with the concept of scientific literacy. What we have emphasised is not so much scientific understanding; the curriculum has the main objective of integrated science rather than thinking of science as physics, chemistry and biology.

School science curricula should provide a variety of learning experiences. It seems that science and technology education in Thailand is not far behind other countries and is moving in the right direction. At the primary and secondary school level, the nature of the disciplines of science and technology and their roles relate to work and daily life. Courses in science and technology are considered to be important and can be related to the real-life situation of the learners. They should provide opportunities for thinking and doing through the active involvement of the student. These courses are then meaningful to the learners in that they want to solve problems by using their scientific skills. Problem solving should be considered more and requires more attention especially at the primary and lower secondary education. Problem solving should be taught at an early age so those children will know how to solve problems better and be able to do it naturally. We should motivate children to think and develop the skills for solving problems when they are young and perceptive.

In order to solve problems, students should recognise that a new situation is indeed a problem situation. They must be able to identify the problem, reduce the problem into manageable sequential sub-problems, recall the relevant knowledge and skills previously learned, and search for alternative answers to the problems. Students develop skills for solving problems by repeated exposure to the problem situation. Teachers should have access to a variety of resources to enable them to encourage the development of problem solving abilities in their students. The problem may be a simple one intended for students to encourage them to think from experiences, to express their own ideas, to take responsibility for their own learning and also to encourage learning experiences that promote creativity across a wide range of interests.

Teaching and learning science have been examined in the context of their effectiveness to enhance students' creativity and science ability, especially their problem solving abilities. In order to promote understanding of scientific knowledge at the lower secondary level, more time is given to experimenting. More emphasis is given to exploratory learning. Problem solving skills are built into these activities to encourage learning experiences that promote creativity. Students may work individually or in a group situation applying their skills to problems that require a high level of performance.

At the upper secondary level, there have to be differences in the elective science courses such as electronics and computer science. Students need to be trained well enough to open up discussions of real problems on science and technology issues, such as CAI, experiments in science, computerised simulations, as well as access to the vast information within the internet. Students also have the opportunity to conduct independent research activities, like science projects in their own particular field of interest. This enables them to show creative ability, a strong task commitment, high interest, and gain knowledge about science and technology and the context in which they are used. They can apply these critically and creatively to solve problems and make decisions to improve the quality of life for the present and into the future.

The educational system in Thailand still produces many students who do not like science or are not willing to learn science. Many students are not interested or quickly lose their interest in science because these subjects seem too difficult and abstract, and seem not to be related enough to their environment and life. It has been observed that science teachers in rural areas are still teaching only information and skills with no emphasis on the students’ abilities and interests. Furthermore, there is a lack of qualified science teachers. Most science
teachers in rural areas are not competent and lack opportunities to obtain new knowledge for improving teaching skills. There is evidence that students, when taught by good science teachers, are likely to be more interested in science.

Science teachers need opportunities to improve their teaching status and condition of work. In a world increasingly dominated by technology, emphasis must be placed on the way for teachers to be acquainted with the use of information technology both in the way of using the technology to service education as well as being prepared to master it for working and teaching. There seems to be a shortage of prospects for science teachers. More recently, science education seems to have particularly suffered from the slowing economy which has led to a decrease in the number of teachers, especially in science and technology education.

The tackling of new challenges and directions in science education, such as an integrated disciplinary approach to science in the solving of technological and social problems, requires new concepts of the science teacher. Well-trained and motivated science teachers will have a new challenge in teaching science that balances content and process in learning.

Computers in Science Education

All countries, however, are aware of the need for alternative innovation approaches to make teaching and learning more effective and try to make use of modern technology for improving the teaching and learning process. One example is the use of computers, which are already being used with success to promote scientific literacy. We should accept that computers are effective tools in improving student achievement and to keep pace with the rate of progress of technology in teaching and learning science. There is an increasing emphasis on the use of computers in Thailand. We may identify the use of computers in two ways; first, using the computers as teaching aids (CAI, CAD, CBT) and secondly, the study of computers as a discrete component of the curriculum or in user applications such as word processing and statistical applications, etc. However, the use of computers still varies from school to school. Most schools do not have computers due to the cost involved in purchasing and maintaining the hardware and the software to establish programs. Above all, there is a shortage of trained teachers to operate computer centres.

You should know that, in Thailand, the government is responsible for education policy based on equity, quality control, and standards. Financing education adequately is an urgent task and the government must assume the responsibility for protecting against corruption, and for securing the largest budget share possible for education, which is not an easy task. Above all, for science and technology education, the government should give special attention to promoting equality of opportunity. It should recognise the need to give science teachers and students competence in the use and control of information technology necessary for work and life. The government should also recognise the specific challenge before our country, in facing the twenty-first century. It should accept that the way of life is changing. We must therefore help establish in students a positive attitude toward science and technology in the hope of attaining a rational outlook, open-mindedness, persistence, co-operativeness, critical thinking and tolerance of various opinions, honesty in preserving observations, etc.

The development of science and technology education has been slowed due to national problems flowing from the economic crisis with which Thailand has been struggling painfully. On the one hand, students need to compete in learning science; but on the other, the government is concerned with providing equal opportunities for learning science. Although the students need to take every opportunity for learning and self-improvement, they will not be able to realise their potential unless courses in science are offered to them. They should have increasing opportunities for access to data. Computer technology should enable everyone to gather information and to select, arrange, manage and use it. This is the effective use of modern media. However, science and technology should be a social experience through which everyone in the society learns about themselves, develops interpersonal skills and acquires basic scientific knowledge and skills. It should enable all students to develop an awareness of themselves and their environment. In many cases, such competence and skills are more readily acquired if students have opportunities to try out and develop their abilities by becoming involved in work experiences.

Science is the work of specialists and, therefore, confined to those with special abilities for undertaking hard, experimental work, with the view that scientific knowledge for the understanding of
everyday problems can be part of the tools of every person and should be taught in schools. In order to advance toward a learning society, the government realised the role of science education in economic progress but it seems that it has not equally shared a tendency towards making science available to all students. There is a particular need to emphasise the updating of the curriculum for science and technology education to ensure they respond to the demands of society. Furthermore, there should be an opportunity for people who have left the formal education system due to a lack of financial resource and in order to work with their parents on a farm or plantation. They should have the opportunity to acquire more knowledge in science and technology through short courses in order to apply it in their daily work and life and to teach others in the community. These people also represent a vast resource of experiences that they can share in school. It is becoming more and more difficult to keep up with this intention to make science available for all. While science education is an on-going process of improving the knowledge and skills of talented students, the government will promote specific science schools for them, despite the serious warning of economic and financial crisis in Thailand.

Conclusion
Science and technology education in Thailand is seen as an important issue for the government as well as for AOEID. Even though IPST has managed the development of science and technology education very well so far, there are still too few students who have succeeded in science and science-related areas. Most students study science because it is required for entry to university in order to enter prestigious careers such as those in medicine and engineering. Science and technology should be the subject that all students must learn in order to have a good life and should not be restricted to those students who learn or work in science-related fields. Working in the environment with continuously developing technology, all students should be able to use and control this technology. The teacher’s role will change from teacher to facilitator. Both teachers and students will not be able to avoid new technology and media such as computers, cable and satellite TV education broadcasting, video teleconference, multimedia equipment, interactive information exchange systems (including e-mail and online access to public library databases), computerised simulators and virtual reality systems. The teacher will help their students to evaluate and use effectively the information they have gathered for themselves in their real life situations. Both teachers and students should not fear technology. Science and technology education is not only for science students but also for all people.

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Update on the ICASE Website
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Check out the contact details of more than 140 member organisations of ICASE! Each member organisation with its own website is requested to send details so that a link can be established from the ICASE website.

Find out about the worldwide scientific and technological literacy project called Project 2000+. Exemplars of curriculum materials which have been developed in Project 2000+ workshops conducted by ICASE, will be progressively added to the site as a resource for science teachers.

For further information or to send updates for inclusion on the ICASE website, contact:

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Example of a ‘concept practical’ –
giving meaning to the concept of acceleration

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What is a practical concept?

Practical work can be used for different purposes: Berg and Giddings (1991) distinguish process labs, skill labs and concept labs. In process labs, students develop investigative skills such as formulating a research question, designing a research plan, etc. In skill labs they learn how to use a particular piece of apparatus, a measuring technique, etc. Concept labs are meant to help students gain conceptual understanding. Practical work can be used to illustrate the validity of a theory or show an application, but then it follows the introduction of the theory. However, the theories of physics are (at least to some extent) based on empirical events, not vice versa. Can practicals form the basis on which the concepts of physics are built? The answer is yes, but only if the practical is designed for that purpose. This paper presents an example of a concept lab: the worksheet is given in the box at the end.

How can concepts be developed in a practical?

Phenomena can be described and explained in numerous ways - that is why we have so many arts and sciences. That is also why a few observations in a practical cannot lead to the development of the unique concepts of physics. However, a lab can often show students that their usual, informal descriptions and explanations are not fully consistent or incomplete. If the students themselves reach this conclusion, they may start looking for better descriptions and explanations. Often, they can find these after a suitable adjustment of their existing concepts. To start and maintain this search it is imperative that the right questions are asked by the teacher, the worksheet and fellow students. Discussing the answers in a class debate is an excellent way of making the search explicit. During this debate it is important to check that new explanations and descriptions (1) match the facts, and (2) are coherent and in accordance with the scientific knowledge the students already have. Because students generally lack the necessary overview to deal with the second criterion, the teacher has a guiding and controlling role during this so-called ‘Socratic’ debate.

White and Gunstone (1992) designed a clever structure for this kind of practical called POE (Predict-Observe-Explain). If students predict what will be observed in the practical, they become aware of, and committed to, their existing explanations and descriptions. Observing the facts can make them aware of unsatisfactory aspects of these descriptions and explanations. The phase of explaining, finally, is supposed to contain the Socratic debate indicated above.

Illustration: a concept lab for the concept of acceleration

The worksheet below shows how these ideas were
elaborated in a practical about the concept of acceleration. The practical was used with students in post-O-level courses in Botswana and South Africa. The design, implementation and evaluation of this and two other practicals was part of my PhD study into the role of concept practicals (Dekkers, 1997, 1998). The practical is meant to address the following problem (see also Trowbridge and McDermott, 1981). The students in the target group knew the definition of acceleration quite well. For example, about 75% of them answered question 1 (see the box below) correctly in a pretest. However, in qualitative descriptions of moving objects they did not distinguish between the speed and acceleration of objects. For example, an average of 43% of the students answered in this test that speed and acceleration always change in the same way. This means that for question 2, these students stated that the speed and acceleration of the cricket both decrease during the upward, and both increase during the downward part of its motion. Similarly, 24% stated in question 3 that an accelerated movement in which the acceleration decreases does not exist. 41% stated that the decelerating motorcycle 3 moves in this way, and only 7% stated correctly that motorcycle 2 does. How would your students answer these questions? It appears that students who know the definition of acceleration, and are able to calculate its value in simple standard problems, do not necessarily understand the full meaning of the concept. The practical is meant to help students construct an empirical meaning of the concept. To do so, they must learn to distinguish between speed and acceleration in a qualitative way.

**The ‘scenario’ - what happens during the practical**

The structure of the practical has a ‘path’ for students to follow to the intended conclusions. Of course, what happens in the classroom always differs from what one has planned. However, after several revisions of the worksheet, what happened in class agreed sufficiently with my ‘scenario’ for the most important conclusions to be reached. The practical can be conducted in small groups or with the whole

1 a A car is driving at 10 m/s. It accelerates uniformly in the next 4 seconds to a final speed of 16 m/s. Find the acceleration.

   a = ..............

b The car is going at 16 m/s. Then it brakes; the car gets a constant deceleration of 3.2 m/s². After how many seconds does the car stop moving?

   t = ..............

2 A cricket jumps vertically upwards passing positions 1 then 2 then 3. (See figure 1). Neglect friction. Delete what is incorrect. As the cricket passes point 1:

   The speed is increasing / constant / decreasing.
   The acceleration is increasing / constant / decreasing.

As the cricket passes point 3:

   The speed is increasing / constant / decreasing.
   The acceleration is increasing / constant / decreasing.

3 For three motor cycles, the speed was measured at t = 1s, t = 2s, t = 3s and t = 4s.

   The results are shown in the table. A student states "One of the motor cycles was accelerating, while the value of the acceleration was decreasing."

   This statement is

   A incorrect. A motion of that kind is impossible.
   B correct - motor cycle 1 moves in this way.
   C correct - motor cycle 2 moves in this way.
   D correct - motor cycle 3 moves in this way.
   E incorrect - a motion of that kind is possible, but no motor cycle was moving in that way.

<table>
<thead>
<tr>
<th>Motor cycle</th>
<th>v (in m/s) at t =</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1s</td>
</tr>
<tr>
<td>1</td>
<td>3.0</td>
</tr>
<tr>
<td>2</td>
<td>3.0</td>
</tr>
<tr>
<td>3</td>
<td>12.0</td>
</tr>
</tbody>
</table>

**Figure 1**
class as one team. In both methods, however, it is very important that the students get the opportunity to answer the questions by themselves and forward, discuss and evaluate their own and each other's arguments. The teacher should carefully avoid, at least in the initial and middle stages of the practical, to forward his own view as the correct one. The 'scenario', summarised in figure 2, is as follows.

It is expected that most students predict that the speed and acceleration of objects change in the same way. Next, in section C of the worksheet, they study a ball that rolls down straight rails at different inclines. They are expected to confirm a valid rule that most of them already use; on a downward incline, the speed of the ball increases (if friction can be neglected). Next (section D) a ball rolls down an incline PQTU of which section QT is curved and has a decreasing steepness. A problem is expected to arise; something 'must' decrease, because 'the rail is getting less steep. The speed is the only available candidate to play the role of this 'something': however, the speed increases according to the rule established in section C.

In one class, students formulated the dilemma as follows:

S1: I do not think the rule will be true here [on QT], because the gradient of the slope decreases. And therefore, the speed decreases.

S2: [disagrees] As long as there's a slope, the gradient is a certain number, a positive number, the speed will go on increasing.

Then the students study the balls rolling down the same straight inclines again (section E). They should now focus on the differences rather than the similarities: the speed increases more quickly on a steeper incline. The initial rule is expanded: the speed of objects on downward inclines increases, and the steeper the incline, the quicker the increase. This is used to solve the earlier problem; it can be concluded that the speed of the ball on the curved incline continues to increase, but increases less and less quickly as the ball rolls down.

In the class of S1 and S2, most students agreed with S1 in their predictions. However, they became excited when they watched the ball roll down rail PQTU. A class debate followed that is summarised here. Many students changed their initial view, but S3 still agreed with S1:

S3: The speed changes, and it depends on the slope. If the slope is steep, the speed is higher. Then when it reaches that curve, the steep is rather less. Then the initial speed decreases, at that point.

[A lively debate follows, in which S3, supported by several students, defends his opinion against arguments of many other students. The teacher (T) clarifies the positions and reminds the students of their earlier observation: the speed of the ball increases on the straight inclines, even on those that are not very steep.]

S3: Okay, we observe that the speed increases, faster, on a steep slope. Here we have a

Predict: If a ball rolls down the rails shown in the diagrams, how do v and a change?

Figure 2. Structure of the concept practical about acceleration
steep slope, that is PQ. Then from Q to T.

T: So what happens to the speed, on this slope PQ?

S3: It increases fast.

T: And on QT.

S3: It increases... slow...

T: What did you say now? [All burst out in laughter, become excited.]

S3: [Sounding wronged:] There is a difference! The fact that it increases slower is a difference from the first one. That gives us the decrease.

S4: If the initial velocity was 40 here, then here it will be 44 and here it will be 44.4, but it's increasing. [Later:]

S5: [S3] confuses speed and acceleration. You're talking about the change of speed, you're saying it changes slower. What is getting slow is the acceleration, but the speed will go on increasing. If it was increasing at a rate of 2, say now here it would be increasing at a rate of 0.11.

After discussions of this kind and an overview and evaluation of the arguments at the end, these outcomes are phrased more precisely as: on the curved incline, the speed increases, while the acceleration of the ball decreases. These findings are applied in exercises (section F), that include a comparison with the predictions and relate to prior knowledge.

Prior knowledge

This practical does not involve the introduction of new theory. However, it is essential that the students have the proper knowledge at the start: we want them to be able, in principle, to resolve by themselves the conceptual problems the practical points at. At the start of the practical, well-prepared students identify time, position, distance, displacement and speed as relevant quantities in descriptions of motion. They know the relations between these quantities, and distinguish between descriptions of an instant in time and those of a time interval. In particular, they can distinguish instantaneous from average speed. They can qualitatively describe movements they watch in terms of these quantities. These are not trivial conditions, many students mix up descriptions of instants with those of time intervals. See for example McDermott (1996) for teaching materials that address the conceptual problems involved here. The practical was written for students who know the definition of acceleration and can do simple calculations involving this quantity. The practical is meant to help students relate the definition of acceleration to the proper aspects of real observed events, thus giving the quantity a qualitative, empirical meaning.

It is not difficult to modify the practical for students who do not yet know the definition of acceleration. The modified practical can help them to note that a proper description should specify how quickly the speed changes. It could pave the way for a definition of acceleration by showing the relevance of a quantity that indicates this 'quickness'. All movements studied in the practical are in forward direction and are described as if they are linear, so that we can identify velocity with speed. This means that we describe the movement of the ball on section QT of figure 2 as one in which the speed increases while the acceleration decreases. In a fully correct description, we should distinguish between the tangential and radial velocity and discuss the centripetal acceleration. These considerations were ignored in the practical so as to avoid confusing the students with too much detail. The acceleration involved in changes of the direction of the velocity was dealt with at a later time.

Apparatus

- One steel ball.
  I used ballbearings with a diameter of 2.5 cm, smooth but not new, a gift from a company specialised in drilling rigs for the Kalahari Desert.

- One straight rail, retort stand and clamp: see figure 4 of the worksheet.
  I used a curtain rail (length 1 m, width 1 or 1.5 cm) nailed to a wooden plank.

- One partly straight, partly curved rail PQTU: see figure 2 of the worksheet.
  I used a curtain rail nailed to a wooden frame. Point P was about 0.7 m above ground level, sections PQ, QT and TU were each about 0.8m long. Note: the real set-up was much less steep than figure 2 suggests. The speed of the ball on TU easily gets too big so that you cannot see whether the ball still accelerates or not. My advice: before you build the wooden frame, try out a few shapes PQTU.

Results

The mean score on test questions like question 2
increased from 15-20% before to 60-65% just after the practical. 4 months later the average score was 40-45%. For question 3, the scores before and after the practical had stayed almost the same (for details, see Dekkers 1997). In short, concept practicals can play a positive role in conceptual development, but no miracles are to be expected. In particular, it is quite difficult to properly manage class discussions, especially if you are not used to the method. Class discussions take quite a bit of preparation (can you anticipate the students’ views and answers?), creativity (can you make sense of what they are trying to say and ‘translate’ it for the others?) and flexibility (until the end of the practical, exchanging views is more important than finding the ‘correct’ answer). A poorly conducted class discussion has either no clear conclusions for the students or, conversely, is in fact a teacher-centred lecture. In a well-conducted discussion, however, you will really put your students to work. In my experience, they eagerly respond to this challenge. As a result, you will learn a lot from them about what makes your subject so difficult and interesting. They, in turn, will learn a lot more about physics than can be tested in standard, quantitative questions. Several students in my study stated that for the first time in their school career, these practicals had really forced them to think.

Literature


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**SCHOOL LINKS INTERNATIONAL 1999**

**Celebration of School Science**

Join hands across the world by sharing your science with a school from a different culture. Simply work on a similar theme and tell each other what you learn. Then join in our ‘Celebration of School Science’ by telling us about it. We’ll help with contacts and ideas. So don’t be left out!

All participants will receive certificates. The best group will be part of an international ceremony.

This project is being organised by the Association for Science Education (ASE) in cooperation with ICASE and UNESCO. For further information about how you can become involved in this project, please contact:

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Schools Links International 1999
The Science Centre, TheRunnymede Centre
Chertsey Road, Addlestone, Weybridge KT15 2EP, UK

Fax: +44 1932 570161
Email: caroline@sci-ence.demon.co.uk
# Concept Practical:

## Study of a ball rolling down a curved slope

### A. Aim

In this practical you will learn what makes acceleration a different quantity from speed. First answer the questions below on your own, to find out what you already know about acceleration and speed. You will check your answers in the experiments that follow.

### B. Predictions

Answer the questions below by filling in the boxes labelled 'Answer before the lab'. Fill in S (stays the same), I (increases), D (decreases) or 0 (is zero). If you want to change an answer later, please do so by writing S, I, D or 0 in the box labelled 'At end'. This way, you can quickly see later what you learned in the lab.

In this worksheet, the word 'speed' means 'instantaneous speed'. In all questions you may ignore effects caused by friction. You may assume that the force of gravity that acts on an object is the same no matter where the object is.

<table>
<thead>
<tr>
<th>Answers</th>
<th>before lab</th>
<th>at end</th>
</tr>
</thead>
</table>

A trolley is released at point A of a slope (figure 1): initial speed = 0 m s\(^{-1}\). As the trolley rolls from A to B

1. its speed
   -  
   -  
2. its acceleration
   -  
   -  

See Figure 2. A ball is released at the top of the slope in point P (initial speed = 0 m s\(^{-1}\)). The ball rolls to point U. As the ball rolls from Q to T

3. its speed
   -  
   -  
4. its acceleration
   -  
   -  

As the ball rolls from P to U

5. its speed
   -  
   -  

See figure 3. A ball drops from a table. While the ball falls

6. its speed
   -  
   -  
7. its acceleration
   -  
   -  

---

Science Education International, Vol. 9, No. 3 September 1998 23
C. Observing moving objects

In the following experiments, determine whether your predictions were correct.

Release a ball from the top of a straight, downward rail (see figure 4). Observe what happens to the speed of the ball as it rolls down the slope.

8. The speed of the ball

Next make the slope less steep (see fig. 5) and again observe the ball, released from the top.

9. On the slope that is less steep, the speed of the ball

Pay special attention to the movement between points T and U (this is needed in section E).

10. From T to U, the speed

Use the answers to questions 8-10 to draw a conclusion in question 11.

11. For a ball rolling down a straight slope, the speed............. . (Provided that the effects of friction can be ignored.)

12. Does this rule make sense? Why, or why not? Does it agree with your experiences?.........................

13. Do you think the rule is also true for a curved rail (like QT in figure 6)? Why, or why not? .........................

In section D you will determine by experiment whether the rule holds for a curved rail like section QT.

D. Predictions and observations for a ball on a curved rail.

See figure 6. Imagine that a ball is released from point P. Use question 11 to predict how the speed will change. (Fill in 'predicted in questions 14-16.) Please fill in all predictions before you observe the event.

Then, release a ball from P and observe how the speed changes. (Fill in 'observed' in questions 14-16.)
14. As the ball rolls from P to Q, its speed
15. As the ball rolls from Q to T, its speed
16. As the ball rolls from T to U, its speed

It can be difficult to observe the speed on TU. To answer question 16, the following can help. Release the ball first from T, then from halfway between T and Q, then from Q, then from halfway between Q and P. For each case, observe the final speed at U. Observation: When the ball starts closer to P, its final speed at U becomes greater / stays the same / becomes smaller.

Conclusions:

17. As the ball rolls from Q to T the speed . . . . . . . . because

18. Check question 11, where you found a rule for straight rails. Use your observations to decide whether it is true for curved rails....

Note: In the experiments there was very little friction between ball and rail. If there had been a lot of friction, the speed would first have increased, then become constant (terminal speed). In our case the effects of friction are small and can be ignored.

B. Observing accelerating objects

See figures 7 and 8.

19. Compare the steepness of slopes PQR and STU: the steepest slope is ....

A ball is released from the top of slopes PQR and STU.

20. Compare how quickly the speed of the ball increases for the two slopes: the quickest increase of v occurs on slope . .

21. If the same rail is made less steep, the speed increases more / less / equally quickly.

Remember that acceleration is defined as the change in the velocity per unit time.

22. Compare the acceleration of the ball for slope PQR and slope STU:
   Acceleration on slope . . > Acceleration on slope . .

The two slopes of figures 7 and 8 are combined into one slope: figure 9. The ball would experience a bump on this slope. Therefore we make it smooth, as in figure 10.
Note: section PQ in figure 9 is just as steep as PQ in figure 10. The same is true for sections TU in both figures.

A ball is released from the top of the rail of figure 10. It rolls from P to Q, to T, then to U.

23. Compare the acceleration of the ball on PQ to its acceleration on TU. (Fill in: >, = or <.)
   Acceleration on PQ ...
   Acceleration on TU ...

24. Conclusion: As the ball rolls from Q to T the acceleration ...
   because ...
   ...

Conclusions: Comparing speed and acceleration

Consider the motion of the ball as it rolls from Q to T. Use your answer to questions 17 and 24. It is important to note that the rails of figures 6 and 10 are the same.

25. For a ball rolling down any slope without friction, the speed .........

26. For a ball rolling down a slope, if the steepness of the slope decreases then .........

27. For a ball rolling down a slope, the acceleration does not depend on the ...
   ......... but on the ...

28. Return to questions 3-5. Were your predictions correct? (Fill in answers 'at end'). If some were incorrect, state what you have learned now.

F. Examples and applications

If the results of this practical surprised you, you may have learned something new. You may have learned that the acceleration can decrease even if the speed increases. Perhaps it is still difficult to see how this can be true. The following questions may help.

29. Ball 1 rolls down a slope at 1.8m/s. 2.0s later, its velocity is 2.4m/s
   Ball 2 on another slope starts from rest. After 2.0s the velocity is 1.0m/s
   Find the acceleration of: Ball 1: a=  ms\(^{-2}\). Ball 2:a=  ms\(^{-2}\).
   After 2.0s, which ball has the greatest velocity? .. the greatest acceleration? ...

30a. Answer questions 1 and 2 (page 1, under 'At end'). Explain your answer:
   As the trolley rolls down, the acceleration.. because .........

   b. Assume: The rail is made so steep that it is vertical. Now the trolley
      just falls down! Does the speed change, as it falls?: .........
      Does the acceleration change as the trolley falls?
      The acceleration ...... because .........

   c. Use question b. to answer questions 6 and 7 (page 1, next to 'At end').
Safe science: be protected
A regular column on safety in school science

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(Series #1)

OSHA Laboratory Standard
(29CFR part 1910 Subpart Z)

Providing a safe working environment for employees and students is a serious responsibility for science leaders. In the United States during 1990, OSHA (the government’s department of labor division responsible for employee safety) issued the Science Laboratory Standard for employees working in laboratories (including academic laboratories such as middle and high schools). The term 'laboratory' is defined as “a facility where the laboratory use of hazardous chemicals occurs. It is a workplace where relatively small quantities of hazardous chemicals are used on a non-production basis.”

Most employees are covered by another standard called the Hazard Communication Standard. However, because of the dangers and uniqueness inherent in laboratory work, employers are required to cover laboratory workers (including science teachers) under the Laboratory Standard.

The standard is performance based. This means that OSHA provided the basic outline requirements and then each employer writes a plan tailored to their own needs. For example, plans may vary from district to district but all plans must contain standard operating procedures. Below is a summary of the plan’s basics tenets.

Elements of Plan:

i. Standard operating procedures

ii. Criteria to determine and implement control measures to reduce employee exposure including engineering controls, use of PPE and hygiene practices.

iii. Requirement that fume hoods and other protective equipment are functioning properly and within specific measures.

iv. Provisions for employee information and training

v. Circumstances where laboratory operation requires prior approval from employer

vi. Provisions for medical consultation and examinations

vii. Designation of personnel responsible for implementation of CHP including Chemical Hygiene Officer (CHO) and if appropriate, Chemical Hygiene Committee. The Committee Hygiene Officer is an employer designated employee who is qualified by training or experience to provide technical guidance in the development and implementation of CHP.

viii. Provision for additional employee protection when working with particularly hazardous substances, eg. reproductive toxins, carcinogens.

OSHA compliance officers initiate inspections by reviewing the employer’s plans. They then focus on plan implementation and policing.

No matter where you are geographically, this standard is just that! It is a level of expectation in order to provide for a safer working environment.

Future safety articles in Science Education International will deal with various components of the plan and other safety issues.

(Editor's note: This will be a regular column on safety in future issues.)
Stepping into Science & Technology Project
Workshop Pack

A new pack has been prepared for ICASE Member Associations to promote pre-secondary science and technology.

The purpose of the Pack is to assist you to mount an exhibition table in your school, in the community, at a conference, or in meetings of your Science Teachers’ Association. Or it would help you to run a workshop of pre-secondary practical science and technology activities as a come and share session for delegates.

The theme is international since ICASE is international - remember the ‘I’- but, more importantly, for scientific and technological literacy for all to become a reality the communication and exchange of information between teachers of science and technology on a world-wide basis is essential. On a more national / local scale, communication within the community is equally important, so that community members are aware of what is going on in science and technology education. Working with pre-secondary or primary teachers is also a public understanding of science activity when teachers have not been trained in science and associated subjects.

The Conference Pack is a guide to producing a visual means of communication to a wide audience. We hope you find it useful and are sure that once you have staged your own Come and Share workshop or exhibition you will want to make the next one even better.

Finally, please bear in mind that the Stepping Into Science & Technology Project is not about examinations and tests, it is about learning. Young people undertaking simple projects or activities at an early stage in their lives, without the pressures of examinations, may become more efficient learners in formal classroom situations. The aim of the project is for students to do; to undertake a hands-on activity and explain what they have been doing in their own words. As they progress through the Steps a certificate is awarded at each stage as a means of encouraging and recognising achievement.

We wish you every success with the use of this Pack and only ask that you communicate with ICASE so that you can share your experiences and ideas with others through the Stepping into Science Newsletter.

A copy of the Stepping into Science and Technology Project Workshop Pack will be sent to each ICASE Member Association.

Enquiries should be directed to:

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Chairperson – Pre-secondary Science, ICASE
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Cyprus children’s images of scientists

Ritsa Maria Hadjikyriacou (BSc DIC MSc MSc)
City University, Cyprus

The purpose of this study was to determine if there were gender/age differences in the images that 11 to 14-year-old students have about scientists. From the data we found clear evidence that, as the female students get older they adopt and project a more stereotypic image of the scientists. On the other hand the male students seem, as they get older, to harbour a less stereotypic image of scientists.

The purpose of this study is to investigate what image Cypriot students have of scientists and to examine the effect of gender and age differences on the image of a scientist that they perceived and projected. It is a well-known fact that, in comparison to men, fewer women are found in scientific careers and, as a result, fewer girls elect to study science at school and in higher education (Harvey 1980). Thus in recent years issues of science attitude and gender have been explored through qualitative and quantitative studies. Gender differences have been found in scientific achievement, activities, interest and attitudes.

Furthermore, J. B. Kahle (1988) and A. Kelly (1985) reported that many high school students have a stereotypically masculine image of science. L. Flick (1990) reported that his sample of 47 fifth graders also drew more males than female figures before visits from female scientists. The 549 students in high school biology classes surveyed by Mason, Kahle and Gardner (1991) also tended to draw male scientists. Ormerod and Wood (1983), concluded in their research that sex differences in the direction of children’s interest in science are established well before secondary school age.

In addition to the above, in one of the largest studies, D. C. Fort and H. L. Varney (1989) found that among the 1,600 responses from students in grades 2 through 12 a vast majority of both male and female students depicted male scientists. Overall they concluded that students perceive a scientist mostly as a benevolent white male. Also S. Katsambis (1995), showed that female students had a less positive attitude towards science, participating in fewer relevant extra curricular activities, and aspired less often to science careers.

Background and design of the study

The study focussed on the gender and age of subjects and their perception of scientists. The questionnaire collected the respondents’ pictorial representation of scientists as well as their written ideas.

Each class teacher at each participating school was requested to ask the students in the class to answer the study’s questionnaire. Teachers were asked not to discuss any possible answers or prompt or influence students’ answers in any way.
developed by the author in 1997 for the sole purpose of gathering information for a world-wide investigation into adolescents’ images of science. The questionnaire consisted of eight open-ended, non-factual / subjective questions, since they dealt with aspects of the state of mind of the respondent, and a request for the children to draw their image of a scientist. Also the questionnaire contained three personal questions for gathering background information about the respondents’ gender, age and nationality. The data gathered by the questionnaire were both in written and pictorial form.

The questionnaire had an uncommon structure that was developed to make its image more acceptable to the young respondents. All the questions, along with the request for the drawing, were placed at the top of the questionnaire leaving the rest of the A4 paper blank. The request for the drawing of their image of a scientist was made on a separate line from all the other questions in bold type and underlined in order to ensure that all the children noticed it. The children could answer the questions as well as add any other beliefs or thoughts they had about the scientists.

The students had the option of answering the questionnaire either in English or Greek. The questionnaire was translated into the Greek language in order to give the opportunity for subjects with a poor command of English to participate in the study.

Results

The data gathered were in both pictorial and written form, but for the purpose of this study only the written part was analysed.

Table 1 provides information about the gender and age of the students in this study. The total percentage of male students who participated was 53.8% and of female 46.2%.

Even though an effort was made to gather approximately the same number of questionnaires from each age category we found that a higher number of eleven-year olds returned completed questionnaires.
### Table 1

<table>
<thead>
<tr>
<th>Gender</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Males</td>
<td>176</td>
<td>53.8</td>
</tr>
<tr>
<td>Females</td>
<td>151</td>
<td>46.2</td>
</tr>
<tr>
<td><strong>Total:</strong>**</td>
<td>327</td>
<td>100</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Age</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eleven</td>
<td>102</td>
<td>31.2</td>
</tr>
<tr>
<td>Twelve</td>
<td>80</td>
<td>24.5</td>
</tr>
<tr>
<td>Thirteen</td>
<td>67</td>
<td>20.5</td>
</tr>
<tr>
<td>Fourteen</td>
<td>78</td>
<td>23.9</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td>327</td>
<td>100</td>
</tr>
</tbody>
</table>

The results indicate that the majority of the male students perceived a scientist to be male. On the other hand, none of them conceived a scientists to be, in general, of the female gender. In particular it is evident from the results that a slight majority of the eleven year olds stated that a scientist could be both male and female. On the other hand the majority of the twelve and thirteen year olds maintained that a scientist was primarily male. However, the bulk of the fourteen year old students perceived scientists to be of both genders.

From Table 2 we find that the majority of the female students believe that scientists can be of both genders. In particular the majority of the eleven year olds believe that scientists can be male or female and the bulk of the twelve and the thirteen year olds believed that also. On the other hand the majority of the fourteen year olds believed that scientists are mostly male.

### Table of female gender and age

<table>
<thead>
<tr>
<th>Age</th>
<th>Male</th>
<th>Female</th>
<th>Both</th>
<th>Both, but mostly males</th>
<th>Both, but mostly females</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eleven</td>
<td>13.3%</td>
<td>13.3%</td>
<td>55.6%</td>
<td>17.8%</td>
<td>0%</td>
</tr>
<tr>
<td>Twelve</td>
<td>25%</td>
<td>2.8%</td>
<td>55.6%</td>
<td>11.1%</td>
<td>0%</td>
</tr>
<tr>
<td>Thirteen</td>
<td>22.9%</td>
<td>8.6%</td>
<td>60%</td>
<td>2.9%</td>
<td>5.7%</td>
</tr>
<tr>
<td>Fourteen</td>
<td>34.3%</td>
<td>5.7%</td>
<td>42.9%</td>
<td>14.3%</td>
<td>0%</td>
</tr>
<tr>
<td><strong>TOTAL:</strong></td>
<td>23.2%</td>
<td>7.9%</td>
<td>53.6%</td>
<td>11.9%</td>
<td>1.3%</td>
</tr>
</tbody>
</table>

Overall we can conclude that as the male students grow older their views about the gender of scientists were less stereotypic. On the other hand the opposite happened with the female students who tended to, as they grew older, adopt and project a more stereotypic gender image of scientists.

### 2 Age of scientists

On the whole the majority of the children perceived a middle aged scientist. In particular eleven year olds claimed that scientists could be either middle aged or
young. On the other hand the twelve and thirteen year olds stated that scientists were old. The majority of the fourteen year olds envisaged a middle aged scientist.

Male gender and age

The majority of male eleven year olds stated that scientists could be either middle aged or young. On the other hand, the twelve and thirteen year olds perceived an old aged scientist. The fourteen year olds claimed that the majority of scientists are middle aged. Altogether a majority of male students perceived a middle aged scientist.

Female gender and age

The majority of the female eleven year olds believed that a scientist is young or middle aged, whereas the majority of the twelve year olds believed that a scientist is middle aged to old and the majority of the thirteen year olds believed that scientists are mainly old. On the other hand, the majority of the fourteen year olds believed that a scientist is middle aged or young. The majority of the female students perceived an old aged scientist.

Overall, it can be concluded that the female students have expressed the more stereotypic old age looking image of a scientist whereas the male students have opted for a middle aged scientist.

3 Lifestyle of scientists

The general perception that students put forth for the lifestyle of scientists was that they are dedicated to science (34.4%). On the other hand 32.5% stated that their lifestyle was ordinary, only 2.1% stated that a scientist is always lonely and only 1.8% claimed that scientists have a hyperactive social life

Male gender and age

The majority of male eleven and twelve-year-olds, 45.6% and 36.4% respectively, claimed that the lifestyle of a scientist is ordinary. On the other hand the majority of the thirteen (37.5%) and fourteen (44.2%) year olds claimed that scientists have a lifestyle dedicated to science.

Female gender and age

The majority of the female eleven-year-olds (36.4%) believed that the lifestyle of scientists was ordinary. On the other hand the majority of the twelve, thirteen and fourteen-year-olds, 30.6%, 48.6% and 42.9% respectively, believed that the life of a scientist was dedicated to science.

Overall, we find that the majority of the male students (34.7%) projected the idea that a scientist’s lifestyle is ordinary. It is also evident that as the male students got older they supported the more stereotypic image of a lifestyle dedicated to science. On the other hand the majority (36.7%) of the female students projected the perception that a scientist’s lifestyle was dedicated to science. It is also apparent that as the female students got older they supported the more stereotypic image of a scientist’s lifestyle.

4 Marital status of a scientist

On the whole, and irrespective of gender and age, a slight majority of the students stated that a scientist is normally married. The second most common answer was that a scientist might be married or he might not be, hence leaving as the third most popular answer the one of an unmarried scientist.

Male gender and age

The majority of the male eleven, twelve and thirteen year olds stated that a scientist is in general married. On the other hand the slight majority of the fourteen-year-olds stated that a scientists is normally single, as he was always busy.

Female gender and age

From the results we find that the majority of the female eleven year olds believed that some scientists are married and some are not. On the other hand all the other age categories believed in general that a scientist is single. The main reason they put forth was that a scientist is too busy to get married.
We can conclude from the results that the female students seemed to have a more stereotypic image about the marital life of scientists. Even though both genders seemed to put forward the same reason for the scientist's lack of a partner.

5 Mental abilities of the scientist

Female gender and age

The main bulk of all the age groups of the female students stated that, in general, scientists are very clever individuals. Also a considerable number of students from all age groups, stated that a scientist is a genius.

Overall, we can conclude that all the students irrespective of gender and age perceived a scientist to have superior mental abilities. Also many of the students designate mental ability as the main criterion for becoming a scientist. Characteristically, one of the students stated that "... in order to become a scientist you have to be very clever, otherwise you will not be able to understand all the scientific things." (No: 281, male 14 years old)

The majority of the students stated that a scientist is in general a very clever individual. Also there was a small number of students claiming that, in order to be a scientist, you have to be a genius.

Male gender and age

The majority of all the male age groups stated that all scientists are always very clever. Also it is noticeable that a high number of thirteen year olds perceived a scientist to be a genius. One twelve year old stated that "women can't be scientists because they haven't got enough brains."

A typical representation of a scientist.
No.254 - Female 14 years old
Discussion

The analysis of these data suggests that, among this sample of Cypriot students, females often expressed a more stereotypic image of scientists. It was especially noticeable that there was a difference not only between genders but also between the different age groups. Also it was quite evident that the older female students projected a more stereotypic image of science.

In recent years, in many countries, issues of science attitude and gender have been explored through qualitative and quantitative studies. For example, in the United States of America, textbook companies, teacher training programs and testing agencies take into account gender differences in science as teachers are trained, texts revised, and test items authored (Boone 1997). The whole program aims to increase the number of students, especially women, who pursue science successfully.

In the case of Cyprus, as is evident from the Cyprus government educational statistics, the number of females pursuing a scientific career is reducing, even though the number of students pursuing further education is increasing. It is therefore essential to remedy the situation and eliminate the kind of scientific illiteracy that seems to exist. The situation can be improved by developing a more science friendly curriculum and by retraining science teachers in order to entice female students to pursue a scientific career.

References


New Primary Science and Technology Source Book – Call for activities

ICASE is commencing the preparation of a new Primary Science and Technology Source Book of ideas and activities. Please send your favourite activities for using at school or in Science Fairs to;

Dr Sue Dale Tunnicliffe
Chairperson – Pre-secondary Science, ICASE
18 Octavia, Bracknell, Berkshire RG12 7YZ, United Kingdom
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Science Clubs.

Science Clubs allow members and leaders to choose areas of study according to their interests rather than being constrained by an imposed syllabus. Lateral thinking, enthusiasm and imagination are characteristic of members of science clubs, and they share, develop respect for others and the environment and behave in safe ways. Science and technology follow naturally when real problems are tackled. The photo of members of the International Association of Science Clubs in action illustrates these points.

Oliver Harris, an IASC Committee Member, at the London BAYSDAY Exhibition, with the windmill he had made

For further information about the International Association of Science Clubs please contact: Mr B.J.K. Tricker, The Firs, Southdown Road, Freshwater Bay, Isle of Wight, PO40 9UA, United Kingdom.
Science Across the World remakes its website

A working example of how the Internet can bridge language and cultural differences has been given a facelift after two years in the field and a rising popularity among schoolchildren in 46 countries.

The Science Across the World programme, coordinated by the Association for Science Education in Britain, was one of the first to incorporate a website into an education programme. The programme aims to raise awareness of science and technology issues in society, industry and the environment. The Internet was used initially to allow teachers and students to send information to other schools.

But there is much more to the new site. It is easier to navigate and more visually appealing. Ease of navigation and speed of download are key features. There are no spinning logos: instead there are resource areas, with discussion forums and news sections to contribute to. Nor is it all dull text. Video clips are available. And the whole thing is available in six languages - English, French, German, Italian, Portuguese and Spanish.

Those who dream of using the Internet in schools might like to check how its done in Science Across the World. There are 1 200 schools world-wide using the BP-sponsored programme, and in the last six years it embraces schools in Africa, the AsiaPacific region, Europe and North and South America.

http://www.bp.com/saw

Note to Member Organizations

Please ask your members to submit material to Science Education International. We are looking for:

• Teaching activities and lessons
• Action research articles which talk to the practising teacher
• Research articles which focus on practice, not research strategies
• Informal and non-formal articles which address 'things to do' in these settings

Please include photographs, pictures and drawings

Manuscripts may be sent to: Robin Groves, ICASE Journal Editor
PO Box 244, Mt Hawthorn
WA 6016, Australia

or by email to: grovesr@ozemail.com.au
1998

October 16 - 18
Symposium 'Education of Science Teachers'
Location: Naleczow, Poland
Contact: Jaroslaw W. Dymara
Department of Chemical Education
Maria Curie Sklodowska University
Pl. M.C. Sklodowska 3
20-031 Lublin, Poland
fax: +48 81 533 36 69
email: jdyama@hermes.umes.lublin.pl

November 5 - 7
Annual Conference of the Science Teachers
Association of Ontario
Location: Toronto
Contact: Jon P McGoe, c/o John Paul II Secondary,
1300 Oxford Street East, London, Ontario N5V4P7
email: jmcgoey@quark.physics.uwo.ca
Information is on the website at <www.stao.org>

November 18-22
European Researchers in Didactics of Biology Conference
Location: University of Goteborg, Sweden
Contact: Dr Fred Brinkman, Secretary, IDO Vrije
Universiteit, Amsterdam, Netherlands,
email: <fg.brinkman@ido.vu.nl>

November 22-27
British Council International Seminar
Location: Manchester, United Kingdom
Theme: Science and technology policy: key issues and strategies
Contact: International Seminars, The British Council,
1 Beaumont Place, Oxford OX1 2PJ, United
Kingdom Fax: + 44 1 865 557 368
Email: <international.seminars@britcoun.org>

December 14-18
17th Biennial Conference of the Asian Association
for Biology Education (AABE)
Location: Mercure Hotel, Manila, Philippines
Theme: Biology Education in the Third Millenium:
Focus on Information Technology and Environmental education
Contact: Dr Salvador P. Angtuaco, Biology
Department, Arzeneo de Manila University, Loyola Heights, Quezon City 1108, Philippines
Fax: +63 2 426 6088
Email: <spa@pusit.admu.edu.ph>

1999

January 7 - 9
ASE Annual Meeting
Location: University of Reading, Reading, England
Theme: Science Education in the Computer Age
Contact: ASE Annual Meeting, The Association for
Science Education, College Lane, Hatfield, Herts
AL10 9AA, fax: +44 1707 266 532,
email: <ase@asehq.telme.com>

Following on the success of the 1998 ASE-ICASE
IOSTE International Seminar, a similar international
seminar is being planned to precede the 1999 ASE
Annual Meeting from 4 January.

January 17 - 19
4th National Conference for Primary Teachers
and Educators
Location: Australian National University, Canberra,
Australia
Theme: Literacy in science
Contact: Conference Secretariat, Australian Science
Teachers Association, PO Box 334, Deakin West,
ACT 2600
Fax: + 2 6282 9477 Email: <asta@asta.edu.au>

March
ICASE NVON International Seminar
Location: Netherlands
Contact: Miia Rannikmae, ICASE European
Regional Representative, Department of Science
Didactics, University of Tartu, Lai 40 Tartu EE 2400,
Estonia, fax: +372 7 465 813
email: <miia@queenie.lai.ut.ee>
March 25 - 28
NSTA National Convention
Location: Boston, Massachusetts, USA
Contact: NSTA Conventions Department, 1840 Wilson Blvd, Arlington, VA 22201-3000
email: <conventions@nsta.org>
Join science educators from across the USA and around the world in a huge program catering to the needs of elementary/primary and secondary teachers of science and tertiary science educators. See the website for further information: <http://www.nsta.org>.

June 26 - July 1
World Conference on Science
Location: Budapest
Theme: Science for the Twenty-First Century: A New Commitment
Contact: Secretariat, World Conference on Science, UNESCO, 7, Place de Fontenoy, 75352 Paris, France
Fax: +33 1 45 68 58 23
Email: <confsci@unesco.org>

July 4 - 9
CONASTA - Conference of the Australian Science Teachers Association
Location: University of Adelaide, Adelaide, Australia
Theme: The Spirit of Science
Contact: CONASTA 48 Secretariat, First Floor, 211 Flinders St, Adelaide SA 5000, Australia
Fax: +61 8 8224 0805
Email: <sasta@cobweb.com.au>

July 10 - 16
9th IOSTE Symposium
Location: Durban, South Africa
'Science and Technology Education for Sustainable Development in Changing and Diverse Societies and Environments'
Contact: Mr Alan Pillay, Chairperson IOSTE 9
Faculty of Education, University of Durban-Westville Private bag X54001, Durban 4000, South Africa
Fax: +27 31 204 4866
Email: <spillay@pixie.udw.ac.za>

September 15 - 19
5th International HPSSST Conference
Location: Pavia University, Italy
Contact: Dr Enrico Antonio Giannetto, Dipartimento di Fisica 'A Volta', Università di Pavia, Via A. Bassi 6, 27100 Pavia, Italy, email: <volta99@pv.infn.it>
This conference is being held in conjunction with the European Physical Society's Interdivisional Group on History of Physics and Physics Teaching. See the website for more information: <http://www.cilea.it/volta99>.

October 4 - 8
3rd ICASE Latin American Symposium
Location: Curitiba - Parana State, Federal University of Parana, Brazil
Contact: Department of Educational Methods, School of Education, Federal University of Parana, Rue General Carneiro, 460 2o. Andar, Curitiba - Parana, CEP 80 060 - 150, Brazil.
Phone / fax: +55 41 264 3574
Email: gioppoc@educacao.ufpr.br
The 3rd ICASE Latin American Symposium will be hosted by the Brazilian Association for the Advancement of Science - Parana Section.

2000
April 6 - 9
NSTA National Convention
Location: Orlando, Florida, USA
Contact: NSTA Conventions Department, 1840 Wilson Blvd, Arlington, VA 22201-3000, email: <conventions@nsta.org>.

July 19 - 21
ICASE-CEFIC European Education-Industry Seminar
Location: University of York, York, UK
Contact: Miia Rannikmae, ICASE European Regional Representative, Department of Science Didactics, University of Tartu, Lai 40 Tartu EE 2400, Estonia, fax: +372 7 465 813, email: <miia@queenie.lai.ut.ee>.

August 21 - 27
16th International Conference on Chemical Education
Location: Eotvos University, Budapest, Hungary
Theme: Healthy Living World and Applied Chemistry
Contact: Hungarian Chemical Society, 16th ICCE Secretariat, Theresa Mihalyi, Budapest Fő u. 68, H-1027, Hungary Fax: +36 1 201 8056
Email: mail2.mke@mtesz.hu Preliminary registration is requested by January 31, 1999.
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International Networking in Science Education
at the ASE 1999 Annual Meeting
University of Reading
4 - 9 January 1999

The international programme of conferences will include: Models and modelling in science education; Information and communication technology in science education; Science and technology education; Environmental education.

This links to 300 programme items and 250 exhibits at the ASE Annual Meeting. These all provide opportunities for reporting on the latest developments and initiatives in advancing the Science Project 2000+ goal of scientific and technological literacy for all, as well as appraising recent research and developments in science education.

There are excellent preferential conference rates for members of associations and institutions affiliated to ICASE.

Contact: Conference Office, ASE, College Lane, Hatfield AL10 9AA, UK
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Science Education International is the quarterly journal of the International Council of Associations for Science Education. ICASE was established in 1973 to extend and improve education in science for all children and youth by assisting member associations throughout the world.

This journal provides means for associations, institutions, centres, foundations, companies and individuals concerned with science education, to share perspectives, concerns, ideas, and information which will foster cooperative efforts to improve science education, and which will serve as a chronicle of the advancement of science education throughout the world.

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Contents
ICASE News................................................. 2

Feature Article
STL Teaching - theoretical background and practical findings
Mita Rannikmae.............................................. 7

Science Education Around the World
Inclusion of the nature of science in Turkish science education curriculum (K-11): as a different approach
Luftullah Turkman and Ronald Bonnstetter...................... 15

Science Teacher Education
Enhancing science teachers' learning through pedagogical content knowledge
Harcharan Pardhan and Alan Wheeler.......................... 21

An inset project for science teachers in Rio de Janeiro, Brazil: a grassroots approach
Sandra Escovedo Selles........................................ 26

Safe Science - Be Protected
Ken Roy.......................................................... 29

Research on Curriculum, Teaching and Learning
Effect of Bio-Cosmos 1 overhead projector films on student learning for middle school biology
Mi-e-Sook Choi, Hae-Ae Seo, Sung-Ho Park and Bang-Ho Song ........................................ 31

Calendar ......................................................... 38

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ICASE Summer Symposium at Utrecht

Dennis G Chisman

They drew on examples from chemistry, physics and biology taken from several European countries and from India, USA and Taiwan.

The papers and discussions are being edited by the science education team at the University of Utrecht and will be available in printed and electronic form through the ICASE network within six months. Further information is available from Onno de Jong, Centre for Science and Mathematics Education, Princetonplein 5, 3384 CC Utrecht, Netherlands (Fax: +31 30 253 7494; e-mail: o.dejong@chem.uu.nl).

Dr Onno de Jong (left) and other participants at the ICASE Summer Symposium in Utrecht, June 1998

The successful series of biennial symposia on science education research, held in Dortmund Germany and organised by Hans-Jürgen Schmidt over many years, was continued in June 1998. The symposium, attended by about 50 participants, held in the University of Utrecht, was organised by Dr Onno de Jong, Centre for Science and Mathematics Education.

The theme of the 1998 symposium was Bridging the gap between theory and practice: what research says to the science teacher. The papers presented included learning science through modelling, the transfer of research findings into practice, models of teacher development, exploring aspects of scientific literacy in the classroom and students’ conceptions.

A practical demonstration at the Utrecht ICASE Summer Symposium in June 1998
1998 CEFIC Science Education Award goes to France

Dennis G Chisman

On the occasion of the CEFIC, European Chemical Industry Council, General Assembly in Berlin on 12 June, 1998, Mr Byran Sanderson, newly elected CEFIC President, presented the 1998 CEFIC Science Education Award to Ms Sylvie Riou and her class of students from Collège Jean Moulin, Le Havre, France.

An international Jury selected the winning team from among 26 finalists from 16 European countries. Mr Alain Vassor, Headmaster of the Collège Jean Moulin, received the Science Award Trophy and a cheque for 5000 ECU for the purchase of scientific or pedagogic equipment for the school, while Ms Riou received a cheque for 1500 ECU and the Excellence in Science Education Award Diploma. As part of the Award, the class will be invited to a one-week educational trip to Great Britain.

The winning project, entitled 'Preambule' dealt with the use of artificial and natural molecules in the field of fragrances. It resulted in the creation of a new and original perfume. The International Jury described this work as showing an integrated multidisciplinary
Polish teachers (above) and British teachers (below) receiving their Commendation Awards from Mr Bryan Sanderson, President of CEFIC
approach including science, arts, languages and geography. The project was well presented and close to the interests of young people, enabling both boys and girls of all abilities to make a good contribution.

The second prize went to Ms Regina Dittman of Humboldtschule, Bad Homburg, Germany for the ‘A sip for your health – The Mineral Springs of Bad Homburg’ project.

The third prize was given to Ms Sirpa af Ursin and Ms Anja Lindholm of Sipoo yläast, Sipoo, Finland for the “Glues and Adhesives” project.

Four Honourable Mentions were awarded to schools in the Czech Republic, Poland, United Kingdom and Slovak Republic.

In his comments as President of the Jury, Mr Wilfried Sahm, Director General of the VCI, the German Chemical Industry Association, said “We were impressed by the excellent quality of all European Finalists which may demonstrate that the examples and the experiences of previous Awards had a beneficial effect in creating new pedagogic initiatives”.

The Association of Biology and Geography Teachers in Finland

The Association of Biology and Geography Teachers in Finland (Biologian ja maantieteellinen opettajien liitto BMOL ry) sends our best regards to all the other Member Organizations of ICASE. Our Association has for many years been a passive member of ICASE and now we want to provide some information about our aims and activities.

As a pedagogical association our most important aim is to promote and improve the teaching of biology and geography. In order to do that, among other things we arrange teacher training in different ways and in different kinds of connections. In our annual meetings - the spring, summer and autumn meetings - teacher training is the most important part and we have lectures and workshops about topical issues. Environmental education, health education and international education are the crucial interests of our Association. We are also very interested in all ways of promoting science education.

The main theme of our autumn meeting in October 1998 was the Future. We had lectures about the future of teaching, the future of assessment in schools, the future of biodiversity and the future of the globe. Currently teachers have a growing interest in workshops. This time we had the following topics in our workshops: How to teach astronomy, Geography of hazards, Environmental chemistry, How to organize international projects, How to meet different cultures, Oil and oil damages, Water lab, Computer-aided teaching. This year we were especially pleased with the contribution of ICASE. Ms. Miia Rannikmae, European representative of ICASE, in her workshop demonstrated the STL philosophy by means of example materials.

The Association of Biology and Geography Teachers in Finland was established in 1927 and so last year was the jubilee year with many special activities, when our Association reached the age of 70.

If some Member Organizations of ICASE are interested in getting more information about our Association, please contact:

Association of Biology and Geography Teachers in Finland
BMOL ry
Mechelininkatu 15 B 48
00100 Helsinki
Finland
Fax: + 358 9 4540425
toimisto@bmol.fi
http://www.bmol.fi

1999 CEFIC Science Education Award

This annual Award created by the European Chemical Industry Council and its National Federation Members, recognises excellence in science education achieved by a European secondary school class of pupils aged 12 to 18.

For the winning team the Award comprises:

An invitation to the Award Ceremony;
A one week all expenses paid trip to another European country;
5,000 ECU for the purchase of scientific or teaching equipment for the school of the winning team;
1,500 ECU plus a Diploma of Excellence for the teacher;
Award trophies.

In addition, various other prizes will be awarded to other particularly meritorious entries.

Entries should be sent to your National Industry Federation by April 1 1999.

An independent international Jury will select one team comprising a teacher and a class of pupils who by their innovative project have demonstrated a more effective and attractive way of teaching chemistry or science in general. The Award will be presented at the CEFIC General Assembly in Madrid on 11 June 1999.

For further information contact:
Science and Technology Department, Avenue E. Van Nieuwenhuyse, 4 Box 1, B-1160 Brussels.
Phone: +32 2 676 72 07 Fax: +32 2 676 73 30, e-mail dbr@cefic.be http://www.cefic.org.
NVON/ICASE European Conference
15 – 17 April 1999, Utrecht, Netherlands

The theme for this meeting is Science, communication and cooperation and it is being organised in two parts.

- The Annual meeting of NVON, the Dutch science teachers association is on 16 April. The meeting is also open to international science educators, both to participate and make presentations relevant to the theme to a predominantly Dutch audience.

- An international symposium is being organised by ICASE for Saturday 17 April, for representatives of European STAs and all science educators interested in international science education. Members from all science teachers’ associations are invited to attend and make presentations. ICASE wishes to take this opportunity to present its efforts to rethink the teaching of science in schools through greater attention to STL (scientific and technological literacy). Specifically, the ICASE publication on supplementary teaching materials will be presented, a proposal for an STL certificate award for teachers put forward and details given of a Year 2000 conference on education-industry partnerships will be given.

Contributions to one or both parts of the conference are invited. For NVON members please contact NVON. For others, please contact the ICASE European Representative, Miia Rannikmae (email: miia@lai.ut.ee or fax: + 372 7 465812). For more details please contact the ICASE European Representative.

Update on the ICASE Website
http://sunsite.anu.edu.au/icase

Check out the contact details of more than 140 member organisations of ICASE! Each member organisation with its own website is requested to send details so that a link can be established from the ICASE website.

Find out about the worldwide scientific and technological literacy project called Project 2000+. Exemplars of curriculum materials which have been developed in Project 2000+ workshops conducted by ICASE, will be progressively added to the site as a resource for science teachers.

For further information or to send updates for inclusion on the ICASE website, contact:

Brenton Honeyman
ICASE Past President
Email: brenton.honeyman@questacon.edu.au
Feature Article

STL teaching - theoretical background and practical findings

Miia Rannikmae
ICASE European Representative
Researcher, Centre for Science Didactics, University of Tartu, Estonia

Abstract

This study set out to find out science teachers’ attitudes and opinions about using a STL teaching approach. Six STL modules were tried out, by 20 teachers with 470 students. All teachers were interviewed after the intervention. The students were asked to express their opinions by replying to a number of open-ended questions. The data were analysed, based on three domains: process, attitudinal and instructional domains. The outcomes emphasised the need for in-service guidance to teachers for better understanding of the intention of the module. The study showed gaps between students’ wishes and traditional teaching which influenced heavily science teachers’ attitudes.

Participants at the seminar on 'Scientific and Technological Literacy for All' for Chemistry Teachers in St Petersburg, Russia in May 1998. The resource person is Miia Rannikmae, the ICASE European Representative.
Introduction

Increasingly in the literature, the goal of teaching science is to promote scientific and technological literacy (STL) among students. This is usually taken to mean developing the ability to creatively utilise science knowledge in everyday life; to solve problems, make decisions, etc. The rationale suggested is that students need to cope with the ever increasing pace of change that is taking place in their lives, especially in the area of science and technology. Besides developing these abilities, it is recognised also that education, and this includes science education, needs to promote developments at the intellectual, attitudinal, societal and interdisciplinary levels (NSTA, 1993; Haggis, 1991).

Research has shown that science curricula have traditionally focused on the technical content of science, particularly academic science concepts (Yager, 1993). The teaching sequence has been from fundamental principles, leading to applications of science and technological advances. In such an approach, teaching stressed theoretical aspects over applications and with this, the isolation of school science from social issues. Whilst this meant that school science was presented in a logical fashion (at least from the scientific standpoint), it was free from social values and the impact of economic concerns. And this has led, in the eyes of students, to the impression that science subjects are more difficult, compared with other subjects. And worse, the theoretical approach has meant that science has become divorced from technology, the visual impact on our lives in the home. Science has been considered a pure, rather than an applied, subjects (Holbrook, 1992).

If science education is to play its true role in the education of the child, then it is important that science education objectives should not be separated from general educational goals. This means that, besides promoting empirical knowledge of chemical, physical and biological systems, science education needs to include learning geared to the scientific method of investigation, acquisition of social skills geared to the development or aspirations of the society, development of personal skills of the student and career awareness (Bybee, 1993). And clearly, specifying the goals and objectives is not only important for the teacher. Research carried out by Melton (1978) showed that 64% of students, who recognised the educational objectives, achieved better results on acquiring teaching material essential to these objectives. Hence objectives in the social skills part of science education, specified in the curriculum, should be particularly emphasised to balance acquisition of cognitive gains. In fact, science carefully taught in an everyday context has been shown to give higher motivation to learners and help them prepare for their future careers (Yager, 1996).

In recent years there have been big changes in the economy of post Soviet countries. Linked to this, post Soviet countries have started educational reforms to help faster integration into European society. In the new curriculum compiled in Estonia, emphasis is placed on science content which has an interdisciplinary character. The methodology of teaching is based on promoting scientific method. Not developed, nor emphasised, is the way of teaching science for all students and hence attention to motivational aspects. The general part of the new curricula, which indicates the need for social and personal development, has not been linked with the science curriculum. And as the assessment objectives for science are very poorly expressed, there is little incentive for teaching materials to develop the social aspect.

Yet there is urgent need in Estonia, with the rapid changes in lifestyle and the economic developments of the country, to work out an approach which will help students and teachers cope better with the changes in the society and at the same time appreciate the new curriculum developments.

Research, carried out (Holbrook and Rannikmae, 1996; Rannikmae, 1996) has shown that the methodology of teaching science is a very important factor in promoting higher order thinking skills among students. Methodology of teaching here includes developing a set of supplementary teaching materials meeting STL criteria geared to student participation, promoting educational goals, relating to a concern or issue in society, encouraging higher order thinking skills, including a communication skill component (Holbrook and Rannikmae, 1997). Aikenhead (1994) has pointed out that there are different models for the teaching of STL. In the Estonian context, it would be possible to motivate students through the adoption of a suitable STL approach. This is taken to mean utilising teaching materials which are related to promoting STL among students whilst maintaining students' conceptual development as per conventional courses. In the current study, teaching materials were created in the
Estonian context (Otsnik and Rannikmae, 1997) following Aikenhead’s (1994) classification - casual infusion of STL content. The materials were directly relevant to the classroom situation and were used as one period resources. As this paper follows Holbrook’s paper (Holbrook, 1998), a more detailed description of the criteria used in the creation of the STL materials is not given here.

Research design and methods

Four STL modules were created accordingly to specified criteria (Holbrook and Rannikmae, 1997). These were made applicable to biology, as well as chemistry lessons. Great attention was paid to the title of modules - keeping them as far from science content as possible. The design of the scenario was heavily linked with a common problem in Estonia, often indicating situations familiar from childhood (see titles in Table 1). 20 biology and chemistry teachers were asked to try out the created modules. Teachers were not made familiar with the STL philosophy, all information needed was gained from the teaching materials, which included a teacher’s guide giving teaching/learning objectives and a full teaching strategy. Teachers had a free choice in which grade to use the materials, they were only asked to indicate their choice to the research staff.

All teachers were interviewed after the intervention using half structured questions to determine:

- the goals of the lessons where the materials were used
- what students were learning and the teachers teaching during these lessons
- what were students feelings and concerns
- how the teachers likes these materials and the approach

The students were asked to express their opinions immediately at the end of the lesson by replying to three open ended questions in written format:

- what did you learn during the lesson ?
- how did you like this lesson and why ?
- would you like to have more, similar lessons ?

All data collected were analysed qualitatively based on three domains:

- process domain (what students were learning and teachers teaching)
- attitudinal domain (feelings and concerns related to personal and social development)
- instructional domain (understanding the goals of teaching - learning)

The total number of students taught by 20 teachers was 470. However, the number of completed replies was smaller - some students felt a lack of time for replying at the end of the lesson.

Research findings

A. Students’ learning

Students’ written answers were analysed against the goals of learning set up in the modules. Following the expressions used by students, learning was divided into three domains: subject knowledge, subjects skills and educational skills (Table 1) (Otsnik, 1998). Students had been used to learning mainly new knowledge, facts and concepts - in many cases these different expressions had the same meaning as more detailed analyses showed. Students had been learning what teachers were assessing in everyday teaching. Thus the learning domain depended on the type of module - modules where students had to use their subject knowledge in solving problems, or making decisions, were evaluated as equal to the subject skills domain. The major concern for the study was in the educational skills domain, which was little seen by students as a learning component. A different proportion of learning components in the module ‘More than a refreshment …’ was influenced by the teacher’s assessment procedures, where group reports were numerically assessed. Numerical assessment of group reports highlighted the importance of communication skills (oral as well written) in the eyes of students.

B. Teachers’ teaching

The STL materials, as used by teachers, did not introduce new concepts, because teachers used the scripts as revision (following an earlier introduction of the topic linked with the particular STL material). But the thrust of teaching by most teachers was still to give major attention to concepts and skills, with skills useful for everyday life emphasised less (Table 2).

Interviews showed that teachers saw scientific skills in a narrow sense - very few teachers (3 from 20) mentioned planning skills, controlling of variables, etc. The interview showed also similarities between students’ learning and teacher’s teaching - students do understand correctly what is in the teacher’s mind. So much so that when the teacher does not see
<table>
<thead>
<tr>
<th>Title</th>
<th>Black or white - which medicine is better?</th>
<th>What happens to different types of juices left overnight?</th>
<th>Eat more meat, eat more bread (title taken from an Estonian national song)</th>
<th>More than a refreshment, more than a soft drink</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Subject knowledge</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• new knowledge</td>
<td>52</td>
<td>41</td>
<td>23</td>
<td>27</td>
<td>143</td>
</tr>
<tr>
<td>• additional facts</td>
<td>17</td>
<td>13</td>
<td>28</td>
<td>21</td>
<td>79</td>
</tr>
<tr>
<td>• concepts</td>
<td>25</td>
<td>25</td>
<td>4</td>
<td>6</td>
<td>60</td>
</tr>
<tr>
<td>• justification</td>
<td>6</td>
<td>8</td>
<td>9</td>
<td>4</td>
<td>27</td>
</tr>
<tr>
<td>• other</td>
<td>11</td>
<td>14</td>
<td>6</td>
<td>7</td>
<td>37</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>108</td>
<td>100</td>
<td>69</td>
<td>60</td>
<td>337</td>
</tr>
<tr>
<td><strong>Subject skills</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• planning practical work</td>
<td>3</td>
<td>9</td>
<td>1</td>
<td>2</td>
<td>14</td>
</tr>
<tr>
<td>• application of knowledge</td>
<td>12</td>
<td>20</td>
<td>26</td>
<td>25</td>
<td>82</td>
</tr>
<tr>
<td>• explaining</td>
<td>6</td>
<td>7</td>
<td>7</td>
<td>4</td>
<td>23</td>
</tr>
<tr>
<td>• practical manipulation</td>
<td>17</td>
<td>8</td>
<td>2</td>
<td>7</td>
<td>33</td>
</tr>
<tr>
<td>• drawing conclusions</td>
<td>2</td>
<td>-</td>
<td>7</td>
<td>3</td>
<td>12</td>
</tr>
<tr>
<td>• other</td>
<td>7</td>
<td>2</td>
<td>11</td>
<td>9</td>
<td>29</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>45</td>
<td>44</td>
<td>50</td>
<td>40</td>
<td>179</td>
</tr>
<tr>
<td><strong>Educational skills</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• communication</td>
<td>2</td>
<td>2</td>
<td>5</td>
<td>27</td>
<td>36</td>
</tr>
<tr>
<td>• cooperative learning</td>
<td>6</td>
<td>7</td>
<td>15</td>
<td>5</td>
<td>33</td>
</tr>
<tr>
<td>• economic considerations</td>
<td>-</td>
<td>5</td>
<td>5</td>
<td>6</td>
<td>16</td>
</tr>
<tr>
<td>• input of each group member</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>• ability to express oneself</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>17</td>
<td>18</td>
</tr>
<tr>
<td>• solving everyday problems</td>
<td>-</td>
<td>1</td>
<td>3</td>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td>• assessment of students</td>
<td>-</td>
<td>1</td>
<td>9</td>
<td>-</td>
<td>10</td>
</tr>
<tr>
<td>• creativity</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>• other</td>
<td>1</td>
<td>2</td>
<td>9</td>
<td>7</td>
<td>19</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>8</td>
<td>14</td>
<td>28</td>
<td>44</td>
<td>94</td>
</tr>
</tbody>
</table>

| Did not learn                             |                                           |                                                          |                                                                          |                                                                |       |
|                                          | 13                                        | 18                                                       | 4                                                                        | 5                                                              | 40    |

Clearly the objective of teaching, students do not take the associated activity seriously.

Table 3 (Otsnik, 1998) shows that students had very low abilities in planning an experiment and presenting a good record of their activities (tasks). Two STL modules were directed towards planning an experiment which would help to solve a socially important problem (using adsorption in medicine; conditions needed to keep juice fresh). Students were able to follow the simple experiment, memorised from earlier lessons, and did not pay attention to a
Table 2 What teachers taught in the lessons *

<table>
<thead>
<tr>
<th>Aspect taught</th>
<th>No. of teachers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science concepts</td>
<td>12</td>
</tr>
<tr>
<td>Science skills (application of knowledge, doing experiment, recording experimental work data etc.)</td>
<td>16</td>
</tr>
<tr>
<td>Skills useful for everyday life</td>
<td></td>
</tr>
<tr>
<td>- communication</td>
<td>6</td>
</tr>
<tr>
<td>- creativity</td>
<td>4</td>
</tr>
<tr>
<td>- cooperation</td>
<td>4</td>
</tr>
<tr>
<td>- solving social problems</td>
<td>3</td>
</tr>
</tbody>
</table>

* 15 teachers gave several reasons

C. Feelings and concerns

The biggest differences between students’ wishes and teacher’s teaching appeared in the attitudinal domain. Students liked the lessons because of having a possibility to think by themselves without subject centred guidance. They could apply science knowledge in solving everyday problems and communicate with each other (Table 4). Previously, communication within science lessons had been acceptable only in terms of subject oriented tasks between deskmates. Group discussions and groupwork were seen as new phenomena in Estonian schools. Many students linked thinking and communication as dependent events - students had different tasks which push them into thinking before discussion.

In a comparison of students’ opinions with the criteria for STL materials (see the paper by Holbrook), research showed students supported lessons which help them cope with a changing society.

The following characteristics for STL materials were highly appreciated by students:

- Development of higher order thinking skills - represented by students thinking (27%)
- Socially oriented scenario - everyday life knowledge (13%)
- Development of communication skills - communication (18%)

Table 3 Ability to plan an experiment (based on written reports from groups)

<table>
<thead>
<tr>
<th>Stages</th>
<th>Able to do</th>
<th>Not able</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. of groups</td>
<td>%</td>
</tr>
<tr>
<td>Giving goals</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Giving resources</td>
<td>10</td>
<td>40</td>
</tr>
<tr>
<td>Planning</td>
<td>4</td>
<td>16</td>
</tr>
<tr>
<td>Giving plan</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Description of experiment</td>
<td>25</td>
<td>100</td>
</tr>
<tr>
<td>Conclusions</td>
<td>10</td>
<td>40</td>
</tr>
</tbody>
</table>

need to widen their skills. They did not record the group discussions in many cases, as that was not a usual requirement by the teacher. Most groups did not give the plan for the experiment (equating it with giving the resources) and more than half of the groups were not able to draw conclusions (15 from 25 groups). These data illustrate also that most teachers did not understand the goal of the lesson (materials), as all groupwork was assessed numerically with high marks. The target of assessment was a poor description of the experiment carried out and influenced little the existing conclusions.
Table 4  Why students liked lessons

<table>
<thead>
<tr>
<th>Reason</th>
<th>No. of responses</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>362 students</td>
<td>79%</td>
</tr>
<tr>
<td>Thinking by oneself</td>
<td>97</td>
<td>27%</td>
</tr>
<tr>
<td>Communication</td>
<td>66</td>
<td>18%</td>
</tr>
<tr>
<td>Everyday life knowledge</td>
<td>46</td>
<td>13%</td>
</tr>
<tr>
<td>Liking practical work</td>
<td>43</td>
<td>12%</td>
</tr>
<tr>
<td>Something different</td>
<td>32</td>
<td>9%</td>
</tr>
<tr>
<td>Undertaking experiment</td>
<td>24</td>
<td>7%</td>
</tr>
<tr>
<td>Interesting</td>
<td>22</td>
<td>6%</td>
</tr>
<tr>
<td>Gained new knowledge</td>
<td>15</td>
<td>4%</td>
</tr>
<tr>
<td>Other</td>
<td>13</td>
<td>3%</td>
</tr>
</tbody>
</table>

Table 5 lists the reasons why some students, overall 11%, did not like STL lessons. There were a number of students who thought the materials had been too difficult (15 students) or too simple (11 students). Approximately the same number of students had been passive, based on teacher’s opinions during the lessons, but at the same time teachers had not seen their role as improving the student involvement.

Public opinion and the examination system influenced student beliefs - STL type of teaching does not help to pass an entrance examination. That was the main argument against a willingness to use STL materials in every lesson. Students suggested to have STL lessons no often than once in month (There are 8 science lessons in one subject area per month in Estonia).

Development of students’ thinking skills was not appreciated by teachers (only 2 teachers from 20). Teachers did like the groupwork, but in many cases acted as passive observers whilst students were in action. Teachers liked the materials, because these included modern topics.

Interviews showed that teachers expressed their understanding about the scenario as a modern topic. They could find new applications for science knowledge in the STL materials scenario. At the same time, however, they continued to think in the direction from science to society, i.e. how to explain societal problems with the help of previously acquired science knowledge.

D. Understanding the goal of teaching

The STL materials included a teacher’s guide, to help teachers better understand the philosophy behind the teaching, had a full description of teaching strategies and also additional information needed for using the materials in different science subject lessons. (most Estonian science teachers have backgrounds in one subject area). Teaching strategies were linked with the goals of the lessons, which were presented in an unusual order - emphasising general educational goals, rather than subject centred goals.

Interviews with teachers showed that most teachers saw the development of subject skills as the main goal for the lesson (Table 6). This goal was highly prioritised, and separated from a possible social context. Teachers did not pay attention to the development of higher order thinking skills in a social context; higher order thinking skills were understood only in a pure subject context. Teachers’

Table 5  Why students disliked the lessons

<table>
<thead>
<tr>
<th>Reason</th>
<th>No. of responses (51 students)</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Didn’t understand</td>
<td>13</td>
<td>25%</td>
</tr>
<tr>
<td>Too simple</td>
<td>11</td>
<td>21%</td>
</tr>
<tr>
<td>Lack of time</td>
<td>9</td>
<td>18%</td>
</tr>
<tr>
<td>Don’t like practical work</td>
<td>5</td>
<td>10%</td>
</tr>
<tr>
<td>Difficult</td>
<td>4</td>
<td>8%</td>
</tr>
<tr>
<td>Don’t like group work</td>
<td>3</td>
<td>6%</td>
</tr>
</tbody>
</table>
Table 6  Whether teachers liked the materials

<table>
<thead>
<tr>
<th>Positive aspects (19 responses)</th>
<th>Negative aspects (6 responses)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Includes groupwork 16</td>
<td>Text difficult in places</td>
</tr>
<tr>
<td>Includes modern topics 8</td>
<td>Not all students like groupwork</td>
</tr>
<tr>
<td>Develops communication skills 6</td>
<td>Cannot assess</td>
</tr>
<tr>
<td>Encourages student thinking 3</td>
<td></td>
</tr>
<tr>
<td>Makes theory more appealing 2</td>
<td></td>
</tr>
</tbody>
</table>

wording for the goals for the lesson differed from that given in the teachers' guide and hence tended to indicate that teachers:

a) did not understand the goal and philosophy behind the materials; and
b) were so influenced by traditional teaching that they were not able to express the thoughts of others.

Development of subject knowledge had been seen traditionally as the most important goal of teaching, linked with the current assessment practice. The influence of STL materials seems to affect the sequencing of that goal, placing it after the goal of developing subject skills. Teachers who saw both goals as important, still emphasised skills versus knowledge. Future discussion should determine the reasons why educational goals were mentioned by only 4 teachers (from 20) !.

E. Role of teachers' guide

Teachers did not pay much attention to teaching strategies. That was taken as an already 'known and familiar' domain which did not need special explanation. Teachers did mention that there was a number of students not actively involved in lessons, but they did not recognise this as a sign of a lack of their own expertise in guiding the lesson. Only two teachers thought student-centred teaching needed special preparation.

Teachers appreciated additional materials - these were resources where they could find some interesting facts, or explanations, to understand the modules. It appeared that Estonian teachers had a lack of interdisciplinary knowledge. However, the same additional materials were evaluated differently by biology and chemistry teachers. Chemistry teachers liked more biological explanations, but the biology teachers wished to see more chemical equations to illustrate the processes behind the STL materials. (A careful analysis of the reports of groupwork showed that students had written these differently in chemistry and biology lessons: possible calculations were dominating in chemistry lessons, whereas in biology lessons, biological reasoning, unfortunately without links with chemistry, was emphasised).

Conclusions

1. The outcomes of this STL classroom intervention study emphasises the need for in-service guidance to teachers for better understanding of the intentions of the material. The STL modules help teachers broaden their teaching goals, but do not clarify the STL philosophy of teaching. The teachers (four teachers), who did understand the philosophy

Table 7  Teachers' goals for the lessons

<table>
<thead>
<tr>
<th>Goals of the lesson</th>
<th>No. of teachers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Given</td>
</tr>
<tr>
<td>Subject skills</td>
<td>14</td>
</tr>
<tr>
<td>Subject knowledge</td>
<td>12</td>
</tr>
<tr>
<td>General educational goals</td>
<td>4</td>
</tr>
</tbody>
</table>

* 10 teachers emphasised several goals

behind the STL materials, did highlight general educational goals and their achievement using student centred teaching strategies.

2. Using socially oriented, student-centred teaching materials enhanced the positive motivation of students towards learning science. Students appreciated opportunities to think and develop co-operative learning skills as well as
3. The study showed gaps between students’ wishes and traditional teaching which influenced heavily teachers’ attitudes. Students were inclined more towards STL learning than it was acceptable to teachers. Students liked STL lessons because they enriched socially oriented goals, yet at the same time, teachers continued to highlight subject oriented goals for the lesson.

4. STL materials illustrated a lack of interdisciplinary science knowledge among science teachers. The teachers’ narrow understanding of one science subject (chemistry or biology) influenced students’ learning outcomes. The effectiveness of using STL materials suffered because of the poor expertise of science teachers in interdisciplinary areas.

5. Both students and teachers were concerned about the need for assessment based on the STL materials. Students learn what teachers assess. Teachers need detailed guidelines on formative assessment and ownership to encourage change from the old paradigms of assessment.

6. Interviews have been a useful tool for developing better understanding of the STL philosophy. During the discussion, teachers clarified difficult moments in their teaching. The need for teachers ownership in the teaching process was highlighted.

References


Science Education Around the World

Member associations and individuals are invited to contribute to this section. Suitable items include brief accounts of specific projects of international significance, science education in a particular country, or international and regional seminars and conferences.

Inclusion of the nature of science in Turkish science education curriculum (K-11): as a different approach

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(1) College of Education, Afyon Kocatepe University, Usak-Turkey
(2) The University of Nebraska-Lincoln, Nebraska-USA

What is the nature of science?

In spite of the fact that K-11 science teachers have both a science content and science education background, they rarely think or teach much about the processes of science. Many fail to overlay their teaching with an understanding of the nature of science or go beyond a lock step introduction of the scientific method. The scientific method that scientists use in their research and studies can be summarized as follows: (1) observation and problem statement (2) establishing hypotheses (temporary solutions) (3) experiment, design or conduct research in order to disprove the hypothesis (in some cases prove the hypothesis), (4) reach a conclusion and in some cases this conclusion becomes a theory or even a scientific law through further research (Kimball, 1968; Griffith, 1995). Many teachers know these steps and have their students memorize them in science courses. However, do we as teachers know why we follow these steps? Do we leave our students with an understanding of the science behind them?

Although science has very complicated definitions, in essence it is a human endeavor to understand the universe, following the rules of science. Therefore, it becomes important to differentiate between science and non-science. One of the basic differences between science and non-science is that science is observable, experimental, measurable and repeatable by other scientists. Science is not based on faith, tradition or custom. All the above explanations lead to a definition of the nature of science (Kimball, 1968; Kuhn, 1962; Lederman, 1992).

The nature of science is based on our human nature because science is a human endeavor. What is the basic force that leads us to conduct science? Of course, the answer to this question is human curiosity about our physical universe. Since we have a driving
How is the nature of science dealt with in the USA National Science Education Standards?

The recently released USA National Science Education Standards have a number of underlying beliefs including: science is for all students, learning science is an active process, school science reflects the intellectual and cultural traditions that characterize the practice of contemporary science, and improving science education is part of systemic education reform (NRC, 1996).

The standards contain a match to the basic tenets of science previously mentioned, including descriptions on: scientific inquiry, the human aspects of science, and the role that science has played in the development of various cultures (NRC, 1996; Stanley and Brichouse, 1994).

In the nature of science section for grades K through 4, teachers focus primarily on developing the curiosity of children, such as allowing students to ask questions, to find answers to the questions, and to conduct group investigations as well as introducing children to some of the great scientists in history.

In grade levels 5 through 8, in addition to the objectives mentioned above, the standards introduce tentativeness, greater observation skill development, experimentation through inquiry, the testing of explanations and some mathematical models.

The nature of science section for grades 9 through 12, emphasizes the difference between science and non-science. It clearly states that explanations based on myths, personal beliefs, religious values, mystical inspiration, superstition or authority may be personally useful, but they are not scientific.

By the time students graduate from high school, they are supposed to be aware of the nature of science. However, much previous research has shown that high school students and most adults do not understand the nature of science. It will be interesting to see if these non-binding national guidelines have any effect on science curricula and ultimately lead to an improved understanding of the nature of science in the USA.

Why include the nature of science?

Currently, there are a number of problems in the USA and in other parts of the world with regard to science education. Generally, students' enthusiasm for

curiosity to figure out the universe and the world that we live in, every person may be considered a scientist. Therefore, it can be said that curiosity is one of the basic tenets underlining the nature of science. Curiosity is also an essential component of inquiry-based science teaching. In fact, the inquiry method can be accepted as another form of the scientific method. Just as the scientific method defined above, inquiry is based on evidence, a blend of logic and imagination, where science explains and predicts, and where scientists work to avoid bias. However, the order of events and emphasis may differ greatly. Thus, one can start to see that science has more than one approach or method. This thing called science is in fact far more dynamic and exciting than seen by most K-11 science students. This concern will be revisited later in this paper.

Other components

Another important tenet of the nature of science is tentativeness. It means that nothing in science is an absolute truth. This is one of the misconceptions about the nature of science. There is a tendency for students to believe that scientific facts, laws, and theories are unchangeable.

Another tenet relates to the fact that by definition science is a human endeavor in which scientists explore the physical universe by means of certain tools. These tools reveal to us the universe and are constantly subject to change. Therefore, science is a dynamic and on-going activity, not static. This requires open-mindedness so that the nature of science and scientific attitudes, such as curiosity, objectivity, and open-mindedness (no bias) may overlap (Thelen, 1987).

Even though these tenets are commonly accepted within the scientific community, much of the general public believes that science is not for ordinary people but belongs in the world of academia. This flawed understanding places the public outside the scientific community at a time when this basic human endeavor is crucial to addressing our complex social issues and should be of interest to everyone. For example, the most recent science education reform components emphasize "science for all," "science literacy" and "science, technology and society." We must help our teachers, students and the general public to understand the nature of science and that it includes curiosity, tentativeness, and is a human enterprise (Meichtry, 1993; Scharmann, 1988).
science courses declines dramatically after the 5th grade (Baykul, 1990). The general attitude of students toward science is that science is not necessary and that science courses are mostly boring. Students, also, do not seem to understand the purpose of science courses. In some ways, they are right because many school science curricula focus mainly on content rather than on the nature and history of science. Many believe that if curriculum planners and science teachers deal with the nature of science at the same time as with other science objectives, students will be less likely to give up science (Baykul, 1990). Moreover, the nature of science in science curricula may better fit students’ learning styles, such as curiosity, and inquiry teaching and learning.

One of the important concepts in science education reform world-wide and certainly within the U.S.A. national science education standards, is hands-on science. It refers to using simple materials, science projects, and observations. By doing hands-on science in school science courses (K-12 grades), the nature of science would be promoted and supported. Also, the nature of science and scientific method can not be taught merely by including a chapter about the nature of science and scientific methods at the beginning of every science textbook. Instead, the nature of science should be spread throughout the entire curriculum. Many believe that by spreading out the nature of science throughout the whole science curriculum, students’ attitudes toward science would be more positive (Griffiths and Barry, 1993; Meichtry, 1993; Griffiths, 1995).

Cultural differences in understanding the nature of science

Throughout human history, different countries, cultures or civilizations have dominated at different times and have led other cultures and civilizations. For example, some of the major old world dominators included the ancient Greek, Roman, Eastern, Chinese, and several Middle Eastern civilizations. Following these old world cultures, religion served as a major regional influence with the Islamic civilization dominating the middle eastern while the European culture and civilization were heavily influenced by Christianity. During the dark ages or middle ages in Europe, other parts of the world were at their peaks, such as the Chinese, the Mayan in South America, and the Islamic civilizations in the Middle East. Later, the renaissance in Europe gave rise to Western Civilization which in turn influenced the whole world, including science.

The driving force behind this new Western Civilization, whose roots go back to the Roman and especially the Greek Civilizations, was religious reform. The result of this eighteenth century movement in Europe was the separation of church and state and the development of positivism within the science community. Eventually, it spread beyond Europe, to Continental America and the Soviet Russia. In this climate, the nature of science took shape.

During the nineteenth century, through the dominance and influence of the super powers, Western civilization had reached every corner of the world. Many countries adapted western ideals for their countries with minor changes creating a somewhat monoculture for scientific thinking. However, during the twentieth century a new philosophical movement called post-positivism or post-modernism has emerged. The influence of post-modernism can be seen in some aspects of education, especially in the nature of science. This new notion gives credit to the differences and views knowledge as far more contextual than its dogmatic positivist predecessor.

As we enter the next millennium, it is normal that even people who are living in different cultures and countries should share some common values as human beings: values derived from past experiences, such as human rights, welfare and even democracy. However, the protection of our environment and natural resources, as well as our cultural differences must also be priorities.

What role should education and particularly science education play?

Educational research, even cross cultural research, suggests that many of the basic science education tenets described earlier are valid everywhere on earth, such as, hands-on science, science for all, and scientific literacy. Every country should include these ideas in their national science standards or curricula. But we also must recognize that the gathering of scientific knowledge can be accomplished through different scientific methods. In other words, there is not one single process or approach in the scientific method. For example, one research initiative, using western agricultural techniques, replaced indigenous agricultural methods in Africa which resulted in
famine and food and water shortages due to incorrect irrigation. Those people who live in Africa had developed their own agricultural methods over hundreds of years; methods which were suited to the local ecology and had withstood the test of time.

Other countries have had similar experiences and have found that without localizing educational reform components, borrowing or imitating a system or notion sometimes has negative effects resulting in the collapse of the educational system (Griffiths, 1995; Solomon, 1991).

Adapting the nature of science to another culture

With these explanations as background, the final question is how the nature of science can be adapted to another culture in the world. In this case the country of Turkey. Turkey has had many experiences in changing her own educational system throughout history. The country is located between Asia and Europe and has been very close to some major changes in world history. In the past, most of her people immigrated from Central Asia and colonized Asia Minor or Anatolia and were converted to Islam from their native religion. Over time they established their civilization, culture and state which was called the Ottoman Empire. When the empire collapsed, the republic of Turkey emerged and has been through several major transitions since 1923. The ultimate goal of the new young republic was to model western civilization and for that reason education became the focus. Early on many of these changes seemed to be pure imitation, but later efforts recognized the need for contextual adaptation (Turkmen and Bonnstetter, 1997).

As mentioned earlier, the general concepts and tenets of the nature of science in national science standards or curricula should be similar throughout the world. The differences lie in their application and modification for K-11 application. In Turkey, the most recent educational changes involve three focal areas; primary schools (K-8 grades), secondary schools (9-11 grades), and colleges or universities. The primary schools have two levels; elementary (K-5) and middle levels (6-8 grades). Obviously, educational reform must include all levels of education, but due to space limitations, we will focus on the K-11 grades.

First of all, education in Turkey is centralized and science curriculum is the same in every part of the country. In spite of the fact that Turkey is a relatively large country and has geographical, and social or cultural differences between regions, the nature of education is very similar throughout the country.

As previously discussed, during the first level of primary school, the main emphasis should be on building the children's curiosity and problem-solving skills by doing very simple hands-on science projects. This focus allows students to build a firm foundation for understanding their environment and relating to natural phenomena. However, due to the shortage of lab materials for science courses in K-5 grades, teachers tend to not provide these experiences. It would be extremely helpful if teacher guides would show how simple materials can be easily accessed and used from their environments. In addition science school curricula must give credit to group and peer study groups.

In the second level of primary schools (6-8), the current science curriculum is dominated by far too many objectives, a focus on memorization, and is very math dependent. Much of the material is taught in abstract terms making most of the present curriculum cognitively inappropriate. The solution for including the nature of science in the science curriculum between 6th and 8th grades may be: (1) spend more time on observation activities and group projects, (2) for teachers to welcome students' natural curiosity and questions, (3) to give a chance to students to report their own data obtained by them with very simple mathematical and graphical models, (4) to make students understand how scientific explanations should be different based on different interpretations by scientists and give them an opportunity to interpret their own data and projects, and (5) to show tentativeness in science by using texts related to the history of science that relate how scientific ideas or theories have changed over time. In this way the science curriculum will be able better able to promote hands-on science, scientific literacy and the nature of science.

The high school science curriculum (9-11 grades) must build on the previous grade level components plus expand the nature of science discussion to include refinements, such as differentiating science from non-science and exposing the difference between religion and science. Just as science teaching in the U.S.A. has been influenced by Christianity, Turkey has been shaped by the Islamic religion. Williamson, 1987, describes how Turkish voters have in the past mandated that politicians impose strict teaching rules based on social values.
As a result, many science teachers do not address crucial points that would help students understand the differences between science and religion.

To find a solution for this problem, the science curriculum should focus on the differences between the methods of science and religion, including the tentativeness of science, so that students can understand what is science and what is non-science. Although many of our cultural and societal values are not scientific, they are socially meaningful and relevant to the society. Students also should understand that the purpose of science is not to create conflict with religion, but to employ the tools of science to help understand and interpret the physical universe.

Conclusion

We must remember that the scientific method is not a single unique path but must be altered based on the context of the problem and the cultural setting. Only the basic tenets of science are constant. Acknowledgment of these factors allows science teachers to remain true to their cultural and social differences as well as the universal nature of science. By paying attention to these social and cultural differences, the nature of science can be adapted to any national science curriculum without losing the basic tenets of science. Therefore, countries must realize that their goals for science education can only be met by adapting and modifying curriculum to match their unique needs.

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Enhancing science teachers’ learning through pedagogical content knowledge

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This paper examines the process undertaken to develop and implement a coherent and relevant structure for a field-based Subject Specialist Teacher (SST) Programme in Pakistan. While many of the features in the approach are of particular interest to science and mathematics educators in the developing world, the model presented here is also seen to hold promise for teacher education in other contexts. The basic premises for the programme were the strong need for both relevancy and quality in the context of the classroom realities, and were defined in terms of content enhancement together with improved pedagogical skills for the overall improvement of classroom practice. An experimental year-long offering of the SST Programme in both mathematics and science was initiated in mid-1997 at the Institute for Educational Development (IED) at the Aga Khan University in Karachi, Pakistan in collaboration with a number of cooperating schools. The mathematics and science SST Programmes were conducted separately but concurrently. The centrality of attempting to implement specific Pedagogical Content Knowledge (PCK) over a realistic period of time in the candidates’ home schools led to the SST Programme design, which consists of a number of content oriented components and appropriate teaching strategies interwoven with regular classroom practice. This paper examines both formative and summative findings associated with efforts to foster teachers’ PCK learning through a specially designed professional development programme. Specific features of the SST Programme are presented in relationship to both the contextual quality and relevance of the initiative. Challenges and possibilities associated with the basic SST Model are discussed in terms of its viability to serve as a significant change agent within and across schools.

Background

"There was a change in my teaching after attending this programme. I realized that now I can give the students better teacher and better ways of conceptual understanding. It was also noted by me that students were taking a keen interest in the activities." (SST Participant)

The Institute for Educational Development, at The Aga Khan University, has a vision to be instrumental in education reform and improvement in Pakistan. An integral part of this reform has been the on-going cycle of courses offered under the rubric of the Visiting Teacher (VT) Programme which began in 1995. The VT Programme was designed as a two month “Grassroots” teacher education initiative in five areas (Social Studies, English, Maths, Science and Primary Education) and has made an important contribution to IED’s overall efforts in the re-professionalisation of teachers. However, after reflections on experiences acquired during the various offerings of the VT components, it became
knowledge in the respective subject fields through a longer, more in-depth treatment which draws heavily upon their own classroom practice. This need led directly to the development of the Subject Specialist Teacher (SST) Programme which began in July, 1997. This was attempted on an experimental basis and represents another of IED's efforts to meet the expressed professional needs of teachers in the cooperating schools. The broad aims of SST Programme were to clarify and enhance the subject content knowledge of the candidates and to increase their competence and confidence through a field-based professional development process. In short, to enhance candidates 'Pedagogical Content Knowledge (PCK)'. Secondary objectives of the programme were to encourage and support stronger collaboration and collegiality among the participants, and to better prepare them to plan and implement professional in-service projects and other appropriate professional activities.

The enhancement of candidates' Pedagogical Content Knowledge (PCK) leading to improved teacher and student learning, formed the basic rationale of the SST Programme. Course participants holding the pre-requisite VT program certificate were nominated by the cooperating schools and selected in consultation with IED. The strong field-based component of the programme restricted the intake to Karachi schools. However, candidates on the programme represented a cross-section of IED's Karachi 26 cooperating schools reflecting all three systems (government schools, private and Aga Khan Schools).

Basic Model

The SST Programme was designed as a one year, field-based model for participants' professional and academic development. Although the emphasis was primarily on content knowledge, pedagogical aspects were also an integral part of the programme. Most of the programme took place in the participants' home schools. This basic SST model consisted of five major components consistent with current field-based models of teacher preparation (Coker and Wilkerson, 1997)

The initial three week full time content focused component, was held in the summer of 1997 at IED. During this Component, content knowledge for teaching was emphasized through a variety of "hands-on and minds-on" experiences. Importance was also given to teaching and understanding of required content. As such, concepts associated with specific topics with reference to the curriculum, were clarified and immediately applied through micro-teaching with peers.

After the summer vacation, SSTs returned to their respective home schools to carry out their first field-based assignments, for the period August-December 1997. Candidates carried out normal classroom practice but were required to prepare exemplary lessons that permitted students to learn content more directly by active manipulations and sharing their understandings. Selected lessons were formally observed, discussed and improved upon. On the average, at least two classroom observation visits per month per candidate were made by faculty members and Professional Development Teachers (PDTs) during this component. During this period the candidates were also provided with maximum school support by IED for classroom practice. Both the exemplary classroom teaching and unit plans formed part of the assessment for this component. To complement this field-based component, regular seminars were held at IED on selected Saturdays. These seminars addressed the evolving needs of the candidates, and encouraged the sharing of experiences, ideas and other pertinent concerns and content knowledge in the light of the candidates level of subject knowledge and understanding (Harlen, 1997). Saturday seminars also proved to be very appropriate for updating and scheduling of observation visits.

Following this the participants returned, on a full time basis to IED, for one week for component three of the programme with the focus on sharing and discussing difficult content areas and building on the various successes experienced over the first field-based period. In addition to enhancing and clarifying certain scientific and mathematical concepts, time was spend on planning for the second field-based component.

From January-May, 1998 the SST participants once again were in their home school, for the second field-based assignment component. The nature of this fourth component of the programme was similar to the first field-based component, however, candidates were also given limited opportunities to conduct professional development workshops within the ongoing Visiting Teacher Programme at IED.

The full time final component took place at IED,
during the late spring of 1998. Further content knowledge was emphasized and participants also prepared and delivered workshops for their peers. Candidates were also required to prepare specific action plans for their continued professional development responsibilities after the completion of the SST Programme.

**Pedagogical Content Knowledge (PCK)**

It is well known that teachers draw heavily upon their general pedagogical knowledge and their specific subject matter knowledge while teaching. However research indicates that teachers also draw upon knowledge that is specific to the teaching of various disciplines. Shulman (1986) termed this body of teacher knowledge, Pedagogical Content Knowledge (PCK) and argued that PCK went beyond mere knowledge of the subject matter per se to a dimension of subject matter knowledge for teaching.

"Within the category of pedagogical content knowledge I include for the most regularly taught topics in one’s subject area the most useful forms of representations of those ideas, the most important analogues, illustrations, examples, explanations and demonstrations – in a word, ways of representing and formulating the subject that make it comprehensible to others. Pedagogical Content Knowledge also includes an understanding of what makes the learning of specific topics easy or difficult; the conceptions and preconceptions that students of different ages and backgrounds bring with them to the learning of those most frequently taught topics and lessons.” (page 9 – 10)

The construct of Pedagogical Content Knowledge is also related to Dewey’s suggestion that teachers must learn to “Psychologize” their subject matter for teaching to reflect upon disciplinary topics and concepts to make them more accessible to students. PCK also requires teaching, as a central activity, to interpret specific content in light of what they know about the prior knowledge and interest of students.

Pedagogical Content Knowledge as used in the SST Programme was seen to consist of three central components. The first component of PCK included knowledge of students’ understanding, conceptions, and alternate conceptions of particular topics in the subject. To generate meaningful explanations and illustrations, teachers must have sound knowledge about what their students already know about a particular topic and where they are likely to encounter difficulty. A second component of PCK built into the SST Programme was that of curricular knowledge. This includes knowledge of the prescribed “horizontal” curriculum for teaching a particular subject, as well as knowledge about the “vertical” curriculum for that subject. For example, in the SST Science Programme, candidates drew heavily upon their knowledge of the prescribed provincial curriculum for a particular class level (e.g. horizontal component), as well as their knowledge of what students had studied about the topic in the past and what they are likely to encounter in future studies. The third component of PCK refers to knowledge of instructional strategies and representations for teaching particular topics. The SST programme attempted to incorporate ways candidates could add to their repertoires of metaphors, experiments, activities, or explanations which are particularly effective for a specific topic.

Overarching all three central components of PCK (Knowledge of Students’ Understanding, Curricular Knowledge, and Instructional Strategies) was that of the context in which the SST Programme was embedded. Clearly, candidates also must draw upon their understanding of the particular contexts in which they taught and adapt their more general knowledge to specific school settings and individual students. To be effective, PCK must be context-specific and context-sensitive.

While the various components of PCK are difficult to clearly separate in practice, the concept of PCK and its components served as a useful focus for the SST Programme. Continuous assessment was used to evaluate participants throughout all components of the Programme. A variety of evaluative measures were incorporated into the programme which placed strong emphasis on candidates’ ability to operationalise PCK in the context of their own classrooms.

**Classroom Realities of the Programme**

“I come with happiness because I would like to learn more and want to clear my concepts”. (SST Participant)

The SST Programme, as noted earlier, grew out an expressed need to enhance the Pedagogical Content
Knowledge (PCK) of selected candidates in Mathematics and Science who could further promote its continued development in their home schools. The decision to initiate the programme in both Mathematics and Science proved a challenging task with notable successes and challenges.

Thirty One (31) candidates (15 in Mathematics, 16 in Science) all experienced teachers, began the SST Programme, and only one candidate dropped out. Overall, the attendance and punctuality was commendable, given the many contextual difficulties faced by the participants.

Course participants consistently worked hard to complete all required major assignments and other programme related activities. It should be noted, in general, that candidates received strong support from their school administration. Candidates’ progress was monitored and documented through relevant assignments and strategies including unit plans, reflective journals, and other measures of performance. These included pre-test, post-test, assignments, candidates’ own personal reflections, and documents relating to both formative and summative indicators of classroom observations.

Pre-test and post-test measures revealed significant content growth with respect to major concepts and topics like energy, forces in science and, algebra, geometry and number sense in mathematics contained within the intended Pakistan curriculum. The enhanced content knowledge was seen as a major achievement for the Programme and far exceeded any such gain in the pre-requisite Visiting Teacher (VT) Programme.

Generally the candidates’ personal reflections moved well beyond the initial descriptive stage to where they were able to identify certain factors which inhibited student learning in a particular lesson. Many candidates were also able to plan subsequent lessons based upon these reflections and implement new learning.

“I also observed that many weak students were able to complete their work in the given time, which was good progress.”

(SST Participant)

During the initial stage of the classroom observation visits, candidates’ ability to properly manage the classroom for cooperative learning including small groups was one of the areas of general concern noted by the faculty. The regular post-conference discussions following each visit proved invaluable in working out appropriate strategies in consultation with candidates to overcome many of the needed organizational and instructional strategies required for better classroom management. There was a strong and highly visible improvement in the classroom management skills of the candidates, especially evident during the latter part of the programme. With the improved managerial skills candidates were able to provide more time on learning tasks for their students. Coincident with their enhanced managerial skills, candidates were better able to incorporate more directly focused applications of the acquired learning.

“Science teaching and learning can become very interesting if science teachers give demonstrations and then involve students in performing experiments, which can then lead to better understanding and retention of different topics” (SST Participant)

Many of the constraints faced in the programme were related to the heavier than anticipated human resource demands of the initiative. This was exacerbated by the unavailability of two members of the Mathematics SST Team due to maternity leave and the cancellation of an overseas consultant’s visit due to unforeseen circumstances. As a result, a number of programme adjustments were made which proved very demanding for both the faculty members and Professional Development Teachers (PDTs) involved.

The challenges faced by the participants themselves centered largely on the reality of the context in which they attempted to implement the programme objectives. Factors presenting significant challenges included the resistance to change encountered given the nature of the traditional school culture, the large number of students in classrooms, the number of different disciplines taught, and the lack of adequate preparation, planning time, and the necessary skills needed to improvise needed equipment, coupled with the scarcity of classroom resources.

“The most important thing we have learnt is that science teaching does not require costly materials, it can be well taught by using low cost materials which are easily available. The subject can be

24  Science Education International, Vol. 9, No. 4  December 1998
taught in a more practical way than just teaching it as a theoretical subject.” (SST Participant)

“I think concrete materials are very useful in learning because this way students can learn more easily.” (SST Participant)

Conclusion

While clearly a challenging initiative, the SST Programme was considered highly successful in terms of the degree of professional and academic growth achieved by the candidates. Overall programme records, observational visits to schools, SSTs’ sharing of experiences, written reflections and presentations of ‘success’ stories revealed a number of formal and informal indicators for candidates’ ability to continue to work for self-improvement in their pedagogical content knowledge.

It would appear that the SST Programme was, in fact, addressing the contextual needs and realities of selective schools in Pakistan and their demands upon classroom practice. The basic SST model is considered viable in spite of its relatively initial high resource implications, and is seen to hold potential for other subjects and areas (e.g. English, Social Studies, and the field of Primary Education). The school-based strand in the SST Programme lends itself well to the planning and implementing of a part time modular graduate programme. Plans are being made to draw upon the SST experience to enable candidates to acquire cumulative graduate accreditation, over time, leading to an M.Ed. degree. Further, with appropriate modifications, the model is also being applied in another developing country context within the region in the August to December, 1998 period.

Efforts in the SST programme to enhance PCK in the programme included exploring the conceptual and procedural knowledge that candidates brought to their teaching, misconceptions that they hold about certain topics, and the stages of understanding that they are likely to pass through in moving from a state of having only cursory understanding of the topic to a deeper mastery of it. PCK also included candidates’ knowledge of assessing students’ understanding, and diagnosing students misconceptions, and the use of instructional strategies to enable students to connect what they are learning to the knowledge they already possess.

The clear focus and emphasis on the professional development of the classroom teacher in situ, with appropriate and timely content and pedagogical enhancement in an integrated PCK fashion, has been found to have both encouraging and motivating outcomes. Several factors have contributed to these outcomes including the heavy emphasis on the field-based assignments conducted in the candidates’ own context, over a realistic time period. Collectively these factors have undoubtedly led to the successful enhancement of both Pedagogical Content Knowledge (PCK) and the Professional Continuous Karachi based classroom teachers’ development.

References


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An inset project for science teachers in Rio de Janeiro, Brazil: a grassroots approach

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Introduction

It is widely accepted that in-service education of science teachers must be incorporated into their school practice in order to improve the quality of their work, to overcome difficulties or lack of information from initial teacher training and to update new scientific knowledge. Researchers consider that INSET programmes are necessary because many of the classroom problems cannot be anticipated in the initial training courses and only make sense to teachers when they are effectively working at schools (Pessoa de Carvalho & Gil-Perez, 1992). Besides that, they argue that an initial training which included all the requirements of professional work would imply an increase in the length of the courses, which is considered not to be viable. Thus, in-service education becomes part of a ‘continuum’ of the process of professional development.

In Brazil, over the last decade there has been an increase in in-service education initiatives, especially short-term courses and training. Mainly, these initiatives come from the universities and local educational authorities together or not and, lately, federal initiatives have been offered with more frequency. Despite that, little has been published focusing on an evaluation of such initiatives. It is necessary to concentrate on the results of projects dealing with in-service education as well as carrying out research focusing on whether or not the projects have responded to what is both required and desired by the teachers themselves.

This article focuses on an evaluation of the In-Service Education of Science Teachers Project in Rio de Janeiro, Brazil over three years. A description of the general features of the project under evaluation will be given, the methodology used and, finally, comments will be made on the results found.

The project: an analogy

The project, called “One Swallow does not make summer” started in 1995 as the result of a Universidade Federal Fluminense initiative to promote greater interchange with science teachers within a partnership between the ‘Espaço UFF de Ciências’ (for details, see Queiróz and Selles, 1996) and state schools. The analogy is appropriate to explain the way teachers view their work at school and, at the same time, to point out a possible approach for overcoming difficulties. From this perspective, the project targeted science teachers and it was set to improve their practice by offering both theoretical and methodological support. The team responsible for the development of the project included university lecturers and five science teachers with the role of multiplying the ideas raised within the project (they are called ‘multiplier teachers’).

The project was organised into three phases and each of them followed the analogy path. The first one was called ‘the swallows make their nest’, which meant the time to organise the first meetings, to raise questions and themes with the teachers and to decide on a methodology. The second, ‘the swallows set flight’ saw the development of the project in the regions. The third phase represented by ‘the swallows fly back’ is still being run and it means a return to the schools to carry on the work done before.

The project methodology

The main methodological strategy of the project consisted of regional meetings at state schools lasting eight hours each and divided into two parts. The first one was dedicated to discussing educational issues from a theoretical point of view and it offered an opportunity to improve teachers’ awareness of the problems they have to face in everyday school life. The second part of the meetings consisted of workshops within a range of science topics chosen previously by the teachers. Although the project’s main concern was the classroom issues that potentially enable teachers to put new ideas into practice, it also reached another dimension of science
teaching. By recognizing the value of the teacher's work, the project invites other higher hierarchical sectors of the school (such as the head teacher and the local authorities) to get involved in a broader discussion of the questions related to science teaching in schools.

During the three years of the project it has reached 1300 teachers over five regional meetings per year in four cities of the metropolitan area of Rio de Janeiro.

Evaluating the project

An evaluation of the project has been conducted since its first year. It made use of questionnaires and a record of all activities developed by the team. Questionnaires were distributed to the participants on two occasions during the regional meetings. The questionnaires provided data on whether or not the project fulfilled the teachers' needs: the methodological approach; the level of the content; the topics chosen; the real possibility to put the ideas presented into practice; etc.

From a quantitative point of view, the fact that the numbers of participants increased over the time the project has been evaluated was taken as a first indicator of the fulfilment of the objectives proposed.

From the data analysis some results were evident. The first was related to the dynamic used in the meetings which was regarded as appropriate and successful. The fact that the project team went to schools instead of the teachers going to the university was considered a good choice of strategy. The teachers' participation, both in the discussion and in the workshop, enhanced the circulation of new ideas and methodological suggestions within the school environment.

The methodological strategy was considered to be successful and two aspects were highlighted. The first was the role of the 'multiplier teachers' involved in the team responsible for the work being done in the region. Their role was both coordinating and organizing the meetings to spread the ideas of the project in their region. This double function has shown to be the core of a strategy of mediation between the schools and the University. Their role can be defined as 'dissemination agents' within the region in which they work as science teachers. As the teachers themselves were responsible for the organisation of the meeting, they had to make more contact with their colleagues than they normally do in their everyday lives at school. Also, 'teachers who talked to other teachers' seemed to have a greater power of persuasion than being invited by university lecturers. It seems that teachers feel threatened by academics and they also tend to consider the 'multiplier' teachers closer to their 'real world' (Selles, 1992).

The second aspect was the fact that being school based, which is not very frequent in the Brazilian context, the project allowed some teachers, who have little opportunity of in-service education programmes, to become involved in university ventures without leaving the school grounds. Many of them felt stimulated and went back to the university to continue their education.

The strategy takes into consideration that the interaction between university and schools allows the construction of school knowledge in a two-way direction. The fact that teachers talked to teachers about classroom issues appeared to be taken into account more carefully by the participants. On the other hand, the university also benefited from going to schools by building an empirical basis for the theoretical knowledge and introducing many of the academic ideas to the school level. These issues are part of a discussion of the construction of knowledge which, generally, only occurs in academic fields. The shift towards fruitful interchanges which allowed such construction is, undoubtedly, a research source, present in different countries (refer Elliott, 1993 in England and the work of Brandão, 1982 and Demo, 1990 in Brazil).

Another point that was highlighted by the evaluation was that the project did not prioritize the content rather than the pedagogical approach. Theoretically, the project was founded on understanding that content and methodology must come together and discussing one in isolation does not contribute to improve the teaching quality. About this, McDermott (1990) states:

*The effective use of a teaching strategy is frequently guided by the content. If the teaching methods are not studied in the context in which they have to be implemented, teachers could not identify the essential aspects, nor adapt the methodological instructions - presented to them in abstract terms - to their specific subject or new situations.* (p. 2)
Therefore, the project was intended to offer the opportunity for teachers to reflect upon teaching and learning science and also to enhance research and continuing education.

Another aspect is the fact that eighty percent of the workshops were led by science teachers, not by academic lecturers. As these teachers became involved in the project they felt encouraged to present themselves the work they develop in classrooms. Also by participating in the project they went back to an academic environment and continued their education at university. In short this can be considered as a short-term result of the project and their work added an important contribution to the success of the project.

The development of the activities during the years had the institutional support of the Universidade Federal Fluminense, particularly the ‘Espaço UFF de Ciências’ and the Fundação de Amparo à pesquisa do Rio de Janeiro, FAPERJ (Foundation for Research Support of the State of Rio de Janeiro). This fact stresses that a partnership between schools and universities depends on institutional support.

Final comments

The project was a successful partnership between the university and schools, demonstrated by the growth in the number of participants and the acceptance of the project proposal. On one hand, the strength of the project appeared to be the participation of teachers who shared new strategies to be used in science classrooms with others. On the other hand, the academic partner gave the theoretical framework for the teachers that allowed them to introduce innovation and made it possible to understand why they should. The fact that much of the work of the workshops was already developed by other science teachers made the participants more confident in implementing new strategies in their classrooms. This project is defined as short-term in-service education; however, the fact that it occurs periodically places it in between short-term and long-term. The first step of the evaluation gave a broader view of the project, but the impact on the classroom was not investigated; in other words, to what extent the project generated what is called ‘didactic change’ (Gil-Perez, 1995). This aspect represents an expansion of the initial objectives and it seems that it is necessary to focus further on this aspect.

(This work is funded by FAPERJ (Foundation for Research Support of the State of Rio de Janeiro Research). Address: Espaço UFF de Ciências. Rua Jansen de Mello, 174, Niterói, RJ, BRAZIL. Tel 021-6208080. Ramal 247, email: educaçao@urbi.com.br)

References:

Education industry partnership (ICASE/CEFIC)
ICASE and CEFIC (European Chemical Industry Council) have created a partnership linking education and industry, and there have been four conferences on this theme over the last twelve years. The next conference is planned for York, UK in 2000.

As part of the planning for the York conference, and as a means of providing input with a strong ICASE flavour, a two-day workshop is being planned for 19 & 20 April 1999 at CEFIC headquarters in Brussels. Attendance of European teachers representing STAs at the April workshop will be sponsored by the chemical industry. Letters and details have been sent to European members of ICASE by the European Representative. For more details please contact the ICASE European Representative, Miia Rannikmae (email: miia@lal.utt.ee or fax: +372 7465812)
Chemical hazard resource information sheet

In schools where hazardous chemicals (chemicals which, based on scientific research, have proven to be a threat to body health) are used, respect of that chemical for its inherent danger to employees and students needs to be addressed. This can start when an employer purchases a new chemical. The manufacturer or supplier of the chemical should provide a chemical hazard resource information sheet (CHRIS) like a Material Safety Data Sheet (MSDS). In turn, the CHRIS should be made available to the employee who will use or be exposed in some way to the chemical in the workplace. CHRISs are documents that need to provide information about the chemical; e.g., common and chemical name, physical properties, health hazards, reactivity information, control measures and other information.

In a school’s science laboratories, CHRISs are critical to science laboratory safety plans. Access is a priority given the fact that exposure to certain hazardous chemicals can be life threatening for both employees and students. In the spirit of a safety plan, teachers should keep a folder of CHRISs for chemicals being used during an experiment in the laboratory. Should an accident occur, the teacher can simply send the person exposed to the chemical to the nurse or medical support person with the CHRIS. Minimally, a CHRIS notebook of all chemicals used in the laboratory should be available in the science workroom or office areas.

It is recommended that schools that use purchase orders have a printed statement noting CHRISs are required for chemicals and payment for chemicals will be withheld until CHRISs are provided. If a chemical is purchased at a local store, a CHRIS type of document should be secured. Consider the scenario of an employee bringing the chemical into the workplace and another employee being allergic to it. Remember, employees need to have the right of access to this information.

It is advisable that safety plans require the employer to train employees each time a new chemical is introduced into the workplace environment. Science supervisors and teachers should also have documentation of such training programs. It is a good idea to include a standing agenda item on safety in writing for each department meeting. During these sessions, new chemicals and precautions can be addressed.

It would also be prudent to have other chemical reference material above and beyond the CHRIS available. In the United States of America all of these recommendations are required under the Laboratory Standard by the Occupational Safety and Health Administration. The bottom line is accessibility to chemical reference information in a CHRIS-like document and training for employees when new chemicals are introduced into the workplace. Training should also be required for new employees entering the workplace. This helps to secure and maintain a safe work place for employees and students working with hazardous chemicals.
Stepping into Science & Technology Project Workshop Pack

A new pack has been prepared for ICASE Member Associations to promote pre-secondary science and technology.

The purpose of the Pack is to assist you to mount an exhibition table in your school, in the community, at a conference, or in meetings of your Science Teachers' Association. Or it would help you to run a workshop of pre-secondary practical science and technology activities as a come and share session for delegates.

The theme is International since ICASE is international - remember the 'I'- but, more importantly, for scientific and technological literacy for all to become a reality the communication and exchange of information between teachers of science and technology on a world-wide basis is essential. On a more national / local scale, communication within the community is equally important, so that community members are aware of what is going on in science and technology education. Working with pre-secondary or primary teachers is also a public understanding of science activity when teachers have not been trained in science and associated subjects.

The Conference Pack is a guide to producing a visual means of communication to a wide audience. We hope you find it useful and are sure that once you have staged your own Come and Share workshop or exhibition you will want to make the next one even better.

Finally, please bear in mind that the Stepping Into Science & Technology Project is not about examinations and tests, it is about learning. Young people undertaking simple projects or activities at an early stage in their lives, without the pressures of examinations, may become more efficient learners in formal classroom situations. The aim of the project is for students to do; to undertake a hands-on activity and explain what they have been doing in their own words. As they progress through the Steps a certificate is awarded at each stage as a means of encouraging and recognising achievement.

We wish you every success with the use of this Pack and only ask that you communicate with ICASE so that you can share your experiences and ideas with others through the Stepping into Science Newsletter.

A copy of the Stepping into Science and Technology Project Workshop Pack will be sent to each ICASE Member Association.

Enquiries should be directed to:

Dr Sue Dale Tunnicliffe
Chairperson – Pre-secondary Science, ICASE
18 Octavia, Bracknell, Berkshire RG12 7Y2, United Kingdom
Effect of Bio-Cosmos I overhead projector films on student learning for middle school biology
Mie-Sook Choi (1), Hae-Ae Seo (2), Sung-Ho Park (3) and Bang-Ho Song (3)
(1)Teagu Seobu Middle School, Teagu, (2) Korean Education Development Institute, Seoul
(3) Department of Biology Education, Teachers College, Kyungpook National University, Taegu, Korea

Abstract

This study aimed to find out the effect of uses of colorful overhead projector films as teaching resources on students' science learning and assess their quality. Song, et al. (1997) developed 208 colorful overhead projector films, named as Bio-cosmos I, including photographs, pictures, concept maps, and diagrams related to the areas of biology in middle school science textbooks. To examine its effect on student learning and quality, Bio-cosmos I targeted 162 female students of 7th grade during the first semester of 1997 in a girl's middle school, Taegu, Korea. The researcher utilized appropriate films during science classes for 40% of class hours for experimental groups and there was no colorful films used for the control group. An achievement test and questionnaires were developed and administrated. The research results showed that students of the experimental group scored significantly (p < .05) higher on the achievement test compared to the control group. The results also showed that there were significant (p < .05) increases in student scientific thinking ability, comprehension of content, retention of knowledge, and interest while there were no significant increases (p < .05) in creativity and problem solving skills related to science-technology-society issues for students of the experimental group. For the production of quality overhead projector films, it was found that various features of content organization, screen structure, printing quality and instructional strategy needed to be carefully designed. It was concluded that colorful visual teaching resources such as Bio-cosmos I films can improve middle school student science learning. The results of the study also called for further research on the development of high quality, colorful overhead projector films.
Introduction

In 1996, the Korean Ministry of Education revised the existing science curriculum, which became the 6th revised curriculum for school science including middle school level from 7th to 9th grades (Korean Ministry of Education, 1992, 1995). New middle school science textbooks were also published according to the 6th revision. The 6th revision emphasized inspiring students to ask questions with interest and curiosity about natural phenomena, as the newly published textbooks tried to effectively achieve the goals of the 6th revised middle school science curriculum (Kim, 1996). Updated science knowledge and inquiry-based investigation and experiments were added to the new textbooks. However, the new textbooks consist mostly of written texts and a few pictures and diagrams in white and black. Such textbooks would easily make students get bored of science learning and decrease students' curiosity and interest in science.

TIMSS (1996) reported that 97% of 8th grade science teachers in Korea used textbooks during science classes and 77% of them decided topics for science teaching from textbooks. It implied that students in Korean middle school science classrooms spend most of their time referring to textbooks. If Korean science teachers do not use any other teaching resources than textbooks in white and black without colored pictures and diagrams for science teaching, students would rarely become interested in science and curious about natural phenomena and student achievement would hardly be improved.

Teaching can be considered as a process of communication, as teachers introduce the topics of lessons to students and facilitate students' understanding. Teaching resources will effectively enhance communication between teachers and students. Such teaching resources, including colorful overhead films, VTR and multimedia stimulate student interest in lesson topics and enhance student achievement with different instructional strategies (Wright & Govindarajan, 1992).

Overhead projector films have been utilized for a long time since electronic equipment and projectors were introduced in school classrooms. However, there have been few studies to analyze the effectiveness of those films in teaching and learning. Most teachers produce simple overhead projector films with handwriting for their prompt use. Commercial overhead projector films are poorly produced in terms of instructional strategies and graphic skills. Necessary computer hardware and multimedia resources are not properly utilized for their production (Trowbridge & Wandersse, 1996).

Song, et al. (1997) produced a set of colorful overhead projector films for middle school biology teaching. The content of the films was organized based upon the analysis of eight different science textbooks approved by the Ministry of Education.

The films were designed based on various instructional strategies and manufactured using multimedia with newly developed educational software. However, their effectiveness as teaching resources have not been examined.

This study aimed to find out whether the application of colorful overhead projector films, Bio-Cosmos I, increased student understanding of science and interest in natural phenomena. In addition, the quality of overhead projector films was also analyzed through the assessment of student opinions. These findings would provide further information of the elements of enhancing student science learning and improving the quality of overhead projector films as effective teaching resources. The overhead projector films of Bio-Cosmos I would also be powerful teaching resources for the successful implementation of the 6th revised science curriculum in Korean middle schools. Therefore, this study focused on the following two questions: (1) Do the uses of overhead projector films positively impact on student achievement, scientific thinking ability, comprehending content, retaining knowledge, creativity, interest, and problem solving skills related to science-technology-society issues? and 2) What are the characteristics of the overhead projector films in terms of improving instructional efficiency?

Method

Subjects

The population for this study consisted of 162 female 1st graders (12-13 years old; four classes) in a girls' middle school in Taegu, Korea. Four classes were randomly selected from 11 classes and divided into two groups; experimental (82 students of two classes) and control groups (80 students of two classes). There were no significant differences (p<0.05; t = -0.16, df = 160) in student achievement between experimental and control groups at the beginning of this study.

Treatment

The study was conducted during 1st semester from early March to the middle of July in 1997. One of the researchers taught a 'general science' for experimental and control groups. For the experimental group, 33 colorful overhead projector films, which were some of 208 Bio-cosmos I films developed by Song, et al. (1997) were utilized for the study while teaching the unit 'life of plants' of the general science course. The teacher tried to use 33 overhead projector films for 40% of the time period of the classes at least. For the control group, the teacher did not use any of those films at all.

Achievement test and survey instruments

Achievement test

To find out the difference of student achievement
between the experimental and control groups, 20 items based on the content of the unit, 'life of plants' were developed. The twenty items were designed as five-choice and open-ended questions. The test was administered at the end of the semester for the experimental and control groups. The highest score for each item was 5 points and the total score of the test was 100 points at maximum. The content validity and reliability was tested by split-half reliability. The Pearson's correlation coefficient was .60 and this value was compensated to .75 by the Spearman-Brown formula (Byun et al., 1996a).

Science Learning Skills and Attitude Questionnaire

The changes of student scientific thinking ability, comprehension of content, retention of knowledge, creativity, interest, and problem solving skills related to science-technology-society issues were measured by the administration of a thirteen item survey questionnaire at the beginning and end of semester for the experimental group. All of the thirteen questions were responded to through the use of a five-point Likert scale (Byun et al., 1996b).

<table>
<thead>
<tr>
<th>Group</th>
<th>n</th>
<th>x</th>
<th>SD</th>
<th>Df</th>
<th>t</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental (with films)</td>
<td>82</td>
<td>60.00</td>
<td>20.49</td>
<td>160</td>
<td>3.8*</td>
</tr>
<tr>
<td>Control (without films)</td>
<td>80</td>
<td>50.13</td>
<td>20.27</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* p < 0.05

Table 1. Differences in achievement scores between students who were taught with Bio-Cosmos I films and those taught without the films.

<table>
<thead>
<tr>
<th>Learning Skills and Attitudes</th>
<th>Test</th>
<th>X</th>
<th>SD</th>
<th>T</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scientific thinking ability (one item)</td>
<td>Pre</td>
<td>3.05</td>
<td>0.89</td>
<td>2.47*</td>
</tr>
<tr>
<td></td>
<td>Post</td>
<td>3.32</td>
<td>0.83</td>
<td></td>
</tr>
<tr>
<td>Comprehending content (five items)</td>
<td>Pre</td>
<td>3.01</td>
<td>0.95</td>
<td>4.37*</td>
</tr>
<tr>
<td></td>
<td>Post</td>
<td>3.48</td>
<td>0.90</td>
<td></td>
</tr>
<tr>
<td>Retaining knowledge (two items)</td>
<td>Pre</td>
<td>3.17</td>
<td>0.72</td>
<td>2.25*</td>
</tr>
<tr>
<td></td>
<td>Post</td>
<td>3.34</td>
<td>0.71</td>
<td></td>
</tr>
<tr>
<td>Interest (two items)</td>
<td>Pre</td>
<td>3.20</td>
<td>1.05</td>
<td>3.76*</td>
</tr>
<tr>
<td></td>
<td>Post</td>
<td>3.58</td>
<td>0.84</td>
<td></td>
</tr>
<tr>
<td>Creativity (one item)</td>
<td>Pre</td>
<td>3.07</td>
<td>0.50</td>
<td>1.05</td>
</tr>
<tr>
<td></td>
<td>Post</td>
<td>3.18</td>
<td>0.51</td>
<td></td>
</tr>
<tr>
<td>Problem solving skill related to STS</td>
<td>Pre</td>
<td>2.63</td>
<td>0.79</td>
<td>0.40</td>
</tr>
<tr>
<td>Issues (two items)</td>
<td>Post</td>
<td>2.66</td>
<td>0.78</td>
<td></td>
</tr>
</tbody>
</table>

N=82; * p < 0.05

Table 2. Changes in various skills and attitudes for students who were taught with the use of Bio-Cosmos I films.

Science Education International, Vol. 9, No. 4 December 1998
Bio-Cosmos I Film Evaluation Questionnaire

To evaluate the quality of the films, Bio-cosmos I used for the study, an evaluation questionnaire was developed regarding content organization, screen structure, printing quality, instructional strategy and overall opinion (Dick & Carey, 1990; Na & Jung, 1996). There were six items for content organization, five items for screen structure, five items for screen quality, five items for instructional strategy and one item for overall evaluation. Each item was responded to through the use of a three point scale. The indicators, “poor,” “average,” and “excellent” were used for measurement (Cho, 1996). The evaluation questionnaire was administrated at the end of semester for the experimental group.

Table 3. Percentage of student responses to six features of content organization of Bio-Cosmos I films

<table>
<thead>
<tr>
<th>Features</th>
<th>Poor (n*)</th>
<th>Average</th>
<th>Excellent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appropriateness for learner’s level</td>
<td>0% (0)</td>
<td>57.3% (47)</td>
<td>42.7% (35)</td>
</tr>
<tr>
<td>Accuracy</td>
<td>1.2% (1)</td>
<td>45.1% (37)</td>
<td>53.7% (44)</td>
</tr>
<tr>
<td>Summarization</td>
<td>2.4% (2)</td>
<td>26.4% (22)</td>
<td>70.7% (58)</td>
</tr>
<tr>
<td>Richness and Diversity</td>
<td>9.8% (8)</td>
<td>67.1% (55)</td>
<td>23.2% (19)</td>
</tr>
<tr>
<td>Consciousness</td>
<td>7.3% (6)</td>
<td>48.8% (40)</td>
<td>43.9% (36)</td>
</tr>
<tr>
<td>Definiteness</td>
<td>1.2% (1)</td>
<td>63.4% (52)</td>
<td>35.4% (29)</td>
</tr>
</tbody>
</table>

*N = 82

Results and discussions

Student achievement test

Table 1 shows that the students in the experimental group scored significantly (p < 0.05) higher than those in the control group. It was suggested that student achievement was considerably improved by the uses of Bio-cosmos I films-aided instruction.

Science learning skill and attitude questionnaire

Student scientific thinking ability, comprehension of content, retention of knowledge and interest were significantly (p < 0.05) changed between the beginning and end of the semester for the experimental group. The creativity and problem solving skill related to science-technology-society issues were not significantly changed (see Table 2). Consequently, the student scientific thinking ability, comprehension of content, retention of knowledge and interest were improved by the films-aided instruction.

Screen structure

The five items of the screen structure asked for students’ opinions of harmoniousness, letter size and style, grammatical correctness, emphasis, and appropriate amount of content for structuring screens. Most students agreed that harmoniousness, letter size and style, grammatical correctness and emphasis were ‘excellent’ in quality (see Table 4). However, 50.0% of students assessed the film quality as ‘average’ for appropriate amount of content.

Printing quality

There were five items concerning colorfulness, gracefulness, clearness, brightness, and distinctness of the printing quality. Most students agreed that the clearness of printing quality was ‘excellent’. (see Table 5).
Instructional strategy

The five items of the instructional strategy were asked for student’s opinions of motivation and interest, sequence to prior learning, summarization of lesson content, connection to lesson objectives, and active participation. The most students agreed that summarization of lesson content and connection to lesson objectives were 'excellent' in quality (see Table 6).

Overall evaluation

The highest percentage (59.8%) of students assessed the quality of Bio-Cosmos I films as 'excellent' while 28% of student assessed them as 'average.' There was 8.5% of students who assessed the quality as 'very excellent' and 3.7% as 'poor.' There was no student who assessed the quality as very poor. Therefore, 68.3% of students agreed that the quality was excellent or very excellent.

Table 4. Percentage of student responses to five features of screen structure of Bio-Cosmos I films

<table>
<thead>
<tr>
<th>Features</th>
<th>Poor (n*)</th>
<th>Average</th>
<th>Excellent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harmoniousness</td>
<td>1.2% (1)</td>
<td>40.2% (33)</td>
<td>58.5% (48)</td>
</tr>
<tr>
<td>Letter size and style</td>
<td>4.9% (4)</td>
<td>32.9% (27)</td>
<td>62.2% (51)</td>
</tr>
<tr>
<td>Grammatical correctness</td>
<td>0% (0)</td>
<td>26.8% (22)</td>
<td>73.2% (60)</td>
</tr>
<tr>
<td>Emphasis</td>
<td>4.9% (4)</td>
<td>42.7% (55)</td>
<td>52.4% (43)</td>
</tr>
<tr>
<td>Appropriate Amount of Content</td>
<td>4.9% (4)</td>
<td>50.0% (41)</td>
<td>45.1% (37)</td>
</tr>
</tbody>
</table>

*N = 82

Table 5. Percentage of student responses to five features of printing quality of Bio-Cosmos I films

<table>
<thead>
<tr>
<th>Features</th>
<th>Poor (n*)</th>
<th>Average</th>
<th>Excellent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colorfulness</td>
<td>7.3% (6)</td>
<td>46.3% (38)</td>
<td>46.3% (38)</td>
</tr>
<tr>
<td>Gracefulness</td>
<td>17.1% (14)</td>
<td>53.7% (44)</td>
<td>29.3% (24)</td>
</tr>
<tr>
<td>Clearness</td>
<td>12.2% (10)</td>
<td>39.0% (32)</td>
<td>48.8% (40)</td>
</tr>
<tr>
<td>Brightness</td>
<td>14.6% (12)</td>
<td>46.3% (38)</td>
<td>39.0% (32)</td>
</tr>
<tr>
<td>Distinctness</td>
<td>13.4% (11)</td>
<td>54.9% (45)</td>
<td>31.7% (26)</td>
</tr>
</tbody>
</table>

*N = 82

Conclusions and suggestions

The findings in this study concluded that the use of colorful overhead projector films, Bio-Cosmos I, in middle school general science classes significantly enhanced student achievement, scientific thinking ability, comprehension of content, retention of knowledge and interest. However, student creativity and problem solving skill were not much improved by the overhead projector films. Rather, creativity and problem solving skill would be enhanced by other teaching strategies such as hands-on activities, experiments, project-oriented instructions and so on. Or, if the overhead projector films provide students with opportunities to engage in experiments and hands-on activities, the overhead projector films might improve student creativity and problem solving skill. The use of overhead projector films for science teaching may not be the best teaching resource in terms of learner-centered and activity-oriented learning. However, teaching resources of
Table 6. Percent of student responses to five features of instructional strategy of Bio-Cosmos I films

<table>
<thead>
<tr>
<th>Features</th>
<th>Poor (n*)</th>
<th>Average</th>
<th>Excellent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motivation and interest</td>
<td>8.5% (7)</td>
<td>72.0% (59)</td>
<td>19.5% (16)</td>
</tr>
<tr>
<td>Sequence to prior learning</td>
<td>9.8% (8)</td>
<td>56.1% (46)</td>
<td>34.1% (28)</td>
</tr>
<tr>
<td>Summarization of lesson content</td>
<td>3.7% (3)</td>
<td>37.8% (31)</td>
<td>58.5% (48)</td>
</tr>
<tr>
<td>Connection to lesson objectives</td>
<td>2.4% (2)</td>
<td>28.0% (23)</td>
<td>69.5% (57)</td>
</tr>
<tr>
<td>Active participation</td>
<td>7.3% (6)</td>
<td>62.2% (51)</td>
<td>30.5% (25)</td>
</tr>
</tbody>
</table>

*N = 82

overhead projector films can be effective for communicating scientific information between students and teachers and for enhancing student scientific thinking ability and interest.

There were also various features of quality overhead projector films as the study revealed from the evaluation results: The strategies for presenting content need to stress appropriateness for the learner’s level, accuracy, summarization, richness and diversity, consciousness and definiteness. The screen should be structured in terms of harmoniousness, letter size and style, grammatical correctness, emphasis and the appropriate amount of content. Colorfulness, gracefulness, clearness, brightness, and distinctness are graphically designed for printing quality. Overhead projector film producers should carefully refer to various elements of instructional strategies in order to produce quality films for improving science learning. The elements of instructional strategy include motivation and interest, sequence to prior learning, summarization of lesson content, connection to lesson objectives and active participation (Cho & Pak, 1995). Various features identified from the study also provide insights for effective and innovative features in developing overhead projector films, as well as hypertext and multimedia of screen-oriented teaching-learning resources.

References


Science Across the World remakes its website

A working example of how the Internet can bridge language and cultural differences has been given a facelift after two years in the field and a rising popularity among schoolchildren in 46 countries.

The Science Across the World programme, coordinated by the Association for Science Education in Britain, was one of the first to incorporate a website into an education programme. The programme aims to raise awareness of science and technology issues in society, industry and the environment. The Internet was used initially to allow teachers and students to send information to other schools.

But there is much more to the new site. It is easier to navigate and more visually appealing. Ease of navigation and speed of download are key features. There are no spinning logos; instead there are resource areas, with discussion forums and news sections to contribute to. Nor is it all dull text. Video clips are available. And the whole thing is available in six languages - English, French, German, Italian, Portuguese and Spanish.

Those who dream of using the Internet in schools might like to check how its done in Science Across the World. There are 1200 schools world-wide using the BP-sponsored programme, and in the last six years it embraces schools in Africa, the Asia-Pacific region, Europe and North and South America.

http://www.bp.com/saw

Note to ICASE Member Organizations

Please ask your members to submit material to Science Education International. We are looking for:

- Teaching activities and lessons
- Action research articles which talk to the practising teacher
- Research articles which focus on practice, not research strategies
- Informal and non-formal articles which address 'things to do' in these settings

Please include photographs, pictures and drawings

Manuscripts may be sent to: Robin Groves, ICASE Journal Editor
PO Box 244, Mt Hawthorn
WA 6016, Australia

or by email to: grovesr@ozemail.com.au
Calendar

Please forward items for inclusion in the calendar to:
Mr Robin Groves, Editor ICASEJournal, PO Box 244, Mt Hawthorn, WA 6016, Australia.
Fax: + 61 8 9201 0004. Email: grovesr@ozemail.com.au

1999

January 7 - 9
ASE Annual Meeting
Location: University of Reading, Reading, England
Theme: Science Education in the Computer Age
Contact: ASE Annual Meeting, The Association for Science Education, College Lane, Hatfield, Herts AL10 9AA, fax: +44 1707 266 532,
email: <ase@asehq.telme.com>

An ASE-ICASE International Seminar will precede the 1999 ASE Annual Meeting from 4 January.

January 14 - 17
International Meeting of the Association for the Education of Teachers in Science
Location: Austin, Texas, USA
Theme: Passport to professional excellence in science teacher education
Contact: Jim Barufaldi, email: jamesb@mail.utexas.edu
Website: <http://www.aets.unr.edu/AETS/aets99reg.html>

January 17 - 19
4th National Conference for Primary Teachers and Educators
Location: Australian National University, Canberra, Australia
Theme: Literacy in science
Contact: Conference Secretariat, Australian Science Teachers Association, PO Box 334, Deakin West, ACT 2600
Fax: + 6 2682 9477 Email: <asta@asta.edu.au>

March 25 - 28
NSTA National Convention
Location: Boston, Massachusetts, USA
Contact: NSTA Conventions Department, 1840 Wilson Blvd, Arlington, VA 22201-3000
email: <conventions@nsta.org>
Join science educators from across the USA and around the world in a huge program catering to the needs of elementary/primary and secondary teachers of science and tertiary science educators. See the website for further information: <http://www.nsta.org>.

March 28 - 31
National Association for Research in Science Teaching (NARST) Annual Meeting
Location: The Boston Park Plaza Hotel, Boston, USA
Contact: Art White, Executive Secretary of NARST, The Ohio State University, 1929 Kenny Road, Columbus, OH 43210, USA
Fax: + 614 292 1595
Email: awhite@POP.SERVICE.OHIO-STATE.EDU
NARST Website: <http://science.coe.uwf.edu/NARST/NARST.html>

April 15 - 17
NVON / ICASE International Symposium
Location: Utrecht, Netherlands
Theme: Science communication and cooperation
The NVON Annual Meeting will be on 16 April and the ICASE European Symposium on 17 April. A welcome international dinner will be held on 15 April.
Contact: Mia Rannikmae, ICASE European Regional Representative, Department of Science Didactics, University of Tartu, Lai 40 Tartu EE 2400, Estonia, fax: +372 7 465 812
email: <miia@lai.ut.ee>

June 26 - July 1
World Conference on Science
Location: Budapest
Theme: Science for the Twenty-First Century: A New Commitment
Contact: Secretariat, World Conference on Science, UNESCO, 7, Place de Fontenoy, 75352 Paris, France
Fax: + 33 1 45 68 58 23
Email: <confsci@unesco.org>

June 26 - July 2
9th IOSTE Symposium
Location: Durban, South Africa
Theme: Science and Technology Education for Sustainable Development in Changing and Diverse Societies and Environments
Contact: Mr Alan Pillay, Chairperson IOSTE 9 Faculty of Education, University of Durban-Westville Private bag X54001, Durban 4000, South Africa
Fax: +27 31 204 4866
Email: <spillay@pixie.udw.ac.za>
June 27 - 30
ChemEd99
Location: University of Waikato, Hamilton, New Zealand
Contact: Bev Cooper, Fax: +64 7 838 4382
Email: <becooper@waikato.ac.nz>

July 4 - 9
CONASTA - Conference of the Australian Science Teachers Association
Location: University of Adelaide, Adelaide, Australia
Theme: The Spirit of Science
Contact: CONASTA 48 Secretariat, First Floor, 211 Flinders St, Adelaide SA 5000, Australia
Fax: +61 8 8224 0805
Email: <conasta@cobweb.com.au>
Website: <http://www.science.adelaide.edu.au/sasta/conasta>

September 15 - 19
5th International HPSST Conference
Location: Pavia University, Italy
Contact: Dr Enrico Antonio Giannetto, Dipartimento di Fisica ‘A Volta’, Universita di Pavia, Via A. Bassi 6, 27100 Pavia, Italy, email: <volta99@pv.infn.it>.
This conference is being held in conjunction with the European Physical Society’s Interdivisional Group on History of Physics and Physics Teaching. See the website for more information: <http://www.citea.it/volta99>.

September 26 - 29
BioLive99
Location: Waipuna Lodge, Auckland, New Zealand
Contact: BioLive Conference Secretariat, PO Box 900040, Auckland, New Zealand

October 4 - 8
3rd Latin American and Caribbean Symposium of ICASE
Location: Curitiba - Parana State, Federal University of Parana, Brazil
Themes: Promoting scientific and technological culture for all in the 21st Century
Contact: Department of Educational Methods, School of Education, Federal University of Parana, Rue General Carneiro, 460 2o. Andar, Curitiba - Parana, CEP 80 060 - 150, Brazil.
Phone / fax: + 55 41 264 3574
Email: <icase3sl@garoupa.bio.ufpr.br>
Website: <www.ufpr.br/eventos/icase/>

The 3rd ICASE Latin American and Caribbean Symposium will be hosted by the Brazilian Association for the Advancement of Science - Parana Section.

2000

January 6 - 8
ASE Annual Meeting
Location: University of Leeds, Leeds, England
Contact: ASE Annual Meeting, The Association for Science Education, College Lane, Hatfield, Herts AL10 9AA, fax: +44 1707 266 532,
email: <ase@asehq.telme.com>
An ASE-ICASE International Seminar will precede the 1999 ASE Annual Meeting from 4 - 5 January, with an international reception on 3 January.

April 6 - 9
NSTA National Convention
Location: Orlando, Florida, USA
Contact: NSTA Conventions Department, 1840 Wilson Blvd, Arlington, VA 22201-3000,
email: <conventions@nsta.org>.

July 19 - 21
ICASE-CEFIC European Education-Industry Seminar
Location: University of York, York, UK
Contact: Mija Rannikmae, ICASE European Regional Representative, Department of Science Didactics, University of Tartu, Lai 40 Tartu EE 2400, Estonia, fax: +372 7 465 813,
email: <mija@queenie.lai.ut.ee>.

August 21 - 27
16th International Conference on Chemical Education
Location: Eotvos University, Budapest, Hungary
Theme: Healthy Living World and Applied Chemistry
Contact: Hungarian Chemical Society, 16th ICCE Secretariat, Theresa Mihalyi, Budapest Fo u. 68, H-1027, Hungary Fax: +36 1 201 8056
Email: mail2.mke@mtesz.hu Preliminary registration is requested by January 31, 1999.
How to subscribe to

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Bob Lepischak
Neepawa Area Collegiate
PO Box 430, Neepawa MB
Canada ROJ 1HO

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SCHOOL LINKS INTERNATIONAL 1999
Celebration of School Science

Join hands across the world by sharing your science with a school from a different culture. Simply work on a similar theme and tell each other what you learn. Then join in our ‘Celebration of School Science’ by telling us about it. We’ll help with contacts and ideas. So don’t be left out!

All participants will receive certificates. The best group will be part of an international ceremony.

This project is being organised by the Association for Science Education (ASE) in cooperation with ICASE and UNESCO. For further information about how you can become involved in this project, please contact:

Caroline McGrath
Schools Links International 1999
The Science Centre, TheRunnymede Centre
Chertsey Road, Addlestone, Weybridge KT15 2EP, UK

Fax: +44 1932 570161
Email: caroline@sci-ence.demon.co.uk