GIS in e-Learning – maintaining the proportions of user’s pyramid

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Abstract

Following the eEurope and eEurope+ initiatives and in order to broaden the results of the Tiger Leap programme, several eProjects are progressing in Estonia. Conjointly these e-activities will realize the aim of the project eCitizen. e-Learning exists in Estonia as one of the components of other activities. In current paper a concept of GIS in e-Learning is developed. It is based on dividing the community of users into different layers with different needs and number of people. According to this concept, e–learning should also be hierarchical, facilitating step-by-step learning and thus moving to more sophisticated use of the GIS environment. Some concrete projects realised already (EGCD) or under development (SAAGIS) are described and issuing from these – some discussion questions formulated.

Introduction

The Lisbon European Council held on March 23 and 24, 2000, announced the eEurope initiative, paying particular attention to “Education and training for living and working in the knowledge society” (eEurope, 2000). As part of eEurope, the eLearning initiative was launched, with an aim to bring together different education components of eEurope actions. In May 2000, Central and Eastern European Countries (later also Cyprus, Malta and Turkey) started the eEurope+ initiative that mirrors the priority objectives and targets of eEurope, but also “provides for actions which tackle the specific situation of the Candidate Countries” (eEurope+…, 2001).

The European eLearning Summit (held on May 10th and 11th, 2001 at the IBM International Training Centre at La Hulpe in Belgium) accentuated a need “to create a culture of lifelong learning” and “to produce the skilled workers and critical thinkers required by a knowledge economy”, and set up 10 recommendations for the future (European…, 2001). In this document, a great importance is given to the eContent programme (http://www.cordis.lu/econtent/) scheduled to support the development of the digital content market in Europe. In its section on e-learning, the newest action plan, eEurope 2005, foresees virtual campuses for all students and underlines the necessary key skills for knowledge society, which “include basic computer skills – digital literacy – and higher-order skills such as teamwork, problem solving, project management, etc.” (eEurope 2005…, 2002).

The activities described above form the environment where the spatial component of data, information, knowledge and skills should find its best appliance. In fact, manifold real practice exists in the world both in offering e-learning services to study GIS, and in using web-based GIS to study geography, spatial analysis, planning, public administration etc. Numerous universities have virtual campuses. Many GIS companies, starting with ESRI, offer different possibilities for e-learning. Also, it is widely used by UNIGIS. There is a nice Virtual Geography Department supported by NCGIA (http://www.colorado.edu/geography/virtdept/contents.html). However, when looking for the so-called 24/7 offerings in the Internet, for free or not for free, it is easy to get lost. One might be apt to surf around in the sea of occasional case studies, insignificant facts and self-made meaningless maps, instead of acquiring the desired higher-order e-skills.

Rapid development of technology is continuously providing new tools to promote e-learning. To realize their potential, adequately rapid development in methods of teaching is needed. In the context of e-learning the latter means all necessary aids for self-learning, including guides, tutors and ensuring the preliminary knowledge/skills. Study resources have to be proper for a student level.

It is broadly accepted that the GIS community (like the community of any other IS) can be considered as a pyramid of three layers: so-called Doers, Users and Viewers. The upper level of “Doers” consists of data creators and software developers, i.e. GIS professionals, and makes up about one per cent of all community. There are ten times more of “Users”, who apply spatial data in different analyses. As a rule, they are specialists in an application area (planning, environmental protection, epidemiology, military, etc.) and for them, the role of GIS is to support (to a certain extent) the decision-making. Users’ role in data integration and value-addition is increasing nowadays. Due to the growth of analysis capabilities of desktop GIS, the users will have to be more “technology savvy” (Munshi, 2002), first of all, concerning
methods of analysis. Users are becoming more and more important data mediators for “Viewers”, whose number is about nine tenth of the community (in the future probably more) and who are browsing Internet as thin clients. The Viewers are data customers and – as it results from the above-described characteristics of knowledge society – will have to be skilled workers and critical thinkers. In the case of Internet GIS it means digital map literacy: ability for purposeful use of interactive cartographic tools, functionality of which will certainly grow.

Our understanding is that the system of e-learning should comply with the structure of this pyramid and with the needs of doers, users and viewers.

According to traditions, geography as the swain of cartography is meant for spatial data handling. Geography’s mission in general education lies in consolidating and generalising the knowledge of separate natural and social subjects and connecting them to specific space and time (Liiber and Roosaare, 2000). For that reason GIS is a likely tool for school geography as microscope is for biology.

The idea on importance of GIS for school geography is not a new one. In the USA, UK and Canada different attempts of introducing GIS into school geography curricula were made during the nineties (Green, 2001). Aude and Paris (1997) proposed an implementation model for this. However, it is not easy to transform traditional school geography oriented to memorizing facts and descriptions. Even in the USA with its much better preconditions than in Estonia, the use of GIS at schools by students is limited.

As shown by a recent survey (Kerski, 2001) in 71% of schools, only one-tenth or less of the student body uses this technology. According to Fitzpatrick (2001), no state of the USA has made GIS a formal part of the school curriculum. The activities are project-oriented, rely on enthusiastic teachers and technologically interested students, and opportunities of using good local data for solving a real problem may give very interesting and practical results. Both Kerski (2001) and researchers from Hong Kong (Pun-Cheng and Kwan, 2001) denote that the main constraint is the lack of time (first of all, teacher’s time to develop lessons in the USA and limited class time in Hong Kong). Despite the lack of hardware-software-data-training as a very common complaint (also according to our questionnaires during the different follow-up schooling, as well as mentioned by other authors), we agree with Kerski (2001:83), that ‘thinking in a different way is perhaps the one factor that hinders GIS implementation in education most’. Therefore new potentialities, which expand classroom activities with learners’ own interest and initiative, will gain more and more importance. The home computer with an Internet connection and CD-ROM drive will become not panacea but the main companion for a schoolboy to discover new worlds.

In the current paper these general considerations are particularized for Estonia. The first section describes the status of e-activities in Estonia, the role of e-learning and particularly the specifics of spatial applications. Next, some concrete projects realized already or under development, are presented in order to formulate authors’ experience and points of view into some recommendations and discussion questions in the last part of the paper.

**eActivities in Estonia**

In 1991, when Estonia regained its independence, the starting position was quite typical for a Soviet republic: very low level of computerization in society but quite high interest among young people and a relatively good level of academic computer science. At that time academic institutions and schools were at the forefront of ICT use (The Estonian Tiger Leap… 1999). The Estonian public opinion considered the actions of neighbouring countries, Finland and Sweden, as a standard for developing ICT in Estonia.

By 1996, many other spheres (especially banking) had overtaken the schools. In 1996 the Tiger Leap National Program was initiated for modernising the Estonia’s educational system, forming of an open learning environment and for better adaptation to the demands of the information society. To finance this program, including money from the Estimates, the Tiger Leap Foundation (TLF) was founded. The Program consisted of activities in many domains, including assistance to help schools by introducing the necessary software as one of the priority directions. During 1996-2000, 64% of schoolteachers participated in basic computer courses and 15% in advanced courses. Almost all schools have got Internet connection (75% - direct connection). The level of 25 pupils per computer in the schools (15 in districts Hiiumaa … 48 in capital Tallinn) has been reached (ibid.).

GIS and related disciplines are taught at three universities and one high school. Only the Institute of geography at the University of Tartu is providing Internet-based study resources. Several companies using or selling GIS and CAD software offer different training courses. Regio Ltd. among them is also occasionally providing some study resources in the Internet. There are about half dozen map servers in the Internet and 60% of the population will be using the Internet on a daily basis (Odrats, 2002:19).

In Estonia with its small territory and 1.4 million population the number of “local” GIS professionals cannot be large enough to allow building local e-learning services for them. These people, usually personally acquainted to each other, have other possibilities for professional communication and the main route of their professional development goes via postgraduate studies at a university. But much of their professional activity has European and/or broader international context. Therefore we foresee that doers educ ate themselves mostly as members of the global GIS professionals’ community. As postgraduate students they are participating in inter-universities cooperation including both on-site visits and courses from different virtual campuses. As practitioners they may choose different kinds of ODL, for example, virtual campuses, e-School, Teacher’s/learner’s portals.

Virtual campuses. University of Tartu, the main centre of higher education in Estonia, established recently the e-university (http://www.ut.ee/e-vlikool/) in order to institutionalise the web-based teaching and learning. In fact, digital course materials, videoconferences, mail-lists etc. have been widely used already for about five years. While the first learning environment used was the TelsiPro, then the e-university is based on the WebCT software. Also other institutions of higher education are using elements of e-learning, first of all the web-based course materials (free or password protected).

Teacher’s/learner’s portals. The Miksike Learning Environment works for K-12 and homeschoolers. Miksike gives away more than 20 000 worksheets in HTML called eWorksheets, and offers a set of collaborative learning services (http://www.miksike.com/). The School Life (http://www.koolielu.ee/), supported by TLF, includes among the rest extensive amount of study materials made mostly by teachers themselves. Unfortunately, these are often low-quality compilations of “what I found in the Internet” with limited interactivity.

From some of the websites, however, one can find good learning resources.

E-School. As a private initiative, the Look@World Project (http://www.vaatamaailma.ee/) has started to support other public e-activities. E-school as part of the Look@World aims to create a web-based information system on study process and its results. The system should enable personal e-communication of pupils and parents with teachers and directorate. First stage of this system should be completed by the end of 2002.

GIS in e-Learning: the concept

Construction of a pyramid should go from bottom to top. A wide basis of digitally literate, critically thinking viewers creates qualification for educating skilled users able to analyse complex spatial relationships and to present eye-catching results for viewers. Both (including also decision makers as viewers and experts as users of spatial information) form the set of customers, which determines the need for spatial data and is the principal factor to define how many GIS professionals a certain community could afford.

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join with ESRI Virtual campus or UNIGIS. A good initiative towards co-ordinated efforts is the EuroMasterGI – a pan-European post-graduate qualification for professionals active in the field of Geographic Information (http://www.zgis.at/euromastergi/).

Practically all Internet users can be considered as potential viewers of spatial information. Electronic press is increasingly generating map images and hypermaps, public map servers are offering spatial search (“Find that place!”) and the e-services of public administration will include more and more applications of GIS. For this widest category (besides the software Help) a simple, attractive, public and vernacular web page should be provided. It is some kind of proclamation; the links commented there should help to find next steps towards study guides, data and tools. Its slogan may be: about GIS for everybody.

As most important group among viewers we regard young people. This so-called Tiger Leap generation, grown up together with eActivities in Estonia, whose main “toy” is a computer and, whose frame of mind takes information society as inherent, will reveal new leaders of society. It is strategically important that geography has the place that it deserves in their worldview. With this in mind, electronic textbooks should complement the traditional textbooks. There should be eActivities enabling to engage advanced pupils, and incentives to encourage youngsters (e.g. different contests). The GIS-related slogan for that group may be: understand the World and its problems with GIS.

We are sceptical about the inclusion of GIS training into school curriculum and making different technical (and rapidly changing) details obligatory for everybody. Firstly, it is technically unrealistic for Estonia in the near future. Secondly, it is almost useless, like the compulsory learning of programming in schools during the eighties.

Like in other computer-aided fields, first of all in programming, some students will be able to work at GIS companies. They turn into young doers jumping or skipping the user’s status.

Users are the most diverse part of the GIS community. As said before, characteristic for them is expertise in the application area and certain role in the process of decision-making. Concerning e-learning they may be divided into two groups, named “researchers” and “municipal officers”.

A typical researcher knows English, his/her own aim, and is oriented to find partners from other parts of the World. Researchers need some introductory help and then prefer self-study with consultation as appropriate. They are interested in some narrow areas of analysis to see what is behind the buttons in GIS. In Estonian conditions, their education may be based on university course materials using the possibilities of the virtual campus, until this group is not large enough. The possible slogan may be: GIS helps you understand more.

A typical municipal officer knows local conditions very well, has some occasional GIS skills and sometimes-mythical knowledge about GIS, and does not like to deal with theory and with materials in a foreign language. In Estonian conditions, this group is under special attention of GIS companies as customers of customized software and value-added spatial data. There is potential for universities in the future, depending on what kind of certificate a university will offer for successful completion of the study. The possible slogan may be: a degree in GIS – for your success.

The university students will start to ascend the pyramid as viewers and – depending on their specialisation – will stay on the first (science teachers of secondary school) or second level (landscape ecologists, human geographers, geologists etc.), or try to conquer the top (postgraduates in cartography and geoinformatics).

The above-described vision will be realised (making corrections if necessary) step by step by means of certain projects.

**GIS in e–Learning: first steps**

Questions of GIS education, including multimedia, web-based solutions and international cooperation, have been under consideration at the Institute of Geography (University of Tartu) for several years (Roosaare, 1994; Erlingsson and Roosaare, 1995; Roosaare et al., 1999; Liiber and Roosaare, 2001). The biggest project carried out in 1997-2000 under the support of the Open Estonia Foundation and the Tiger Leap Foundation is named EGCD.

EGCD is an electronic textbook (CD-ROM) for teaching Estonian Geography in form 9 (Roosaare et al., 2000). It is one of the few means of instruction that fully meets the requirements of the school programme. EGCD consists of interactive texts, maps, photos, lists of data, and graphical schemes organized on four different levels. It also includes exercises and tests (and necessary software from the third party), a dictionary of terms and a help tool. In the context of the current paper there are two things of interest in EGCD:

- The fourth level, which is meant for teachers and for advanced pupils interested in computer cartography and GIS (Figure 1). Now, this level is set up also in the Internet for free use (http://www.geo.ut.ee/kooligeo/EGCD/opik/juts/juts.html) and is applied by us as an introductory...
e-learning material in different elementary courses. There are also chapters with guides on how to use ArcExplorer and Microsoft Map – the two most accessible mapping tools in schools.

- The EGCD also includes an ActiveX component enabling (in addition to the standard multimedia possibilities) to browse multi-layer vector maps. The component is based on the possibilities of ESRI’s Map Objects LT and consists of two parts:
  o EGCD.Map.View object in the HTML-document. It has the controlling properties of the map window and it allows individualizing each call of the map window.
  o The resizable map window, which uses the spatial data compatible with ArcView and ArcExplorer, and enables (if all potentialities are switched on) to show or hide map layers (both vector and raster), change active layers and layers’ order, make cursor inquiries; measure distances, add pins (symbols) to the map; zoom, pan or print the composition.

There are altogether 50 different map compositions presented on EGCD, making up a school atlas. Its basis, the spatial data files (121 MB on Estonia, 9 MB on Europe, and 2 MB on the Baltic Sea) can also be used to compile custom maps.

A new project being still in its starting stage is named SAAGIS. The whole project is directed to the development of GIS learning environment and includes introduction of software, provision of teaching/learning materials for different levels and preparation of maps to be offered via the ArcIMS based service (http://map.gg.bg.ut.ee/). The project in all is directed to address the whole users’ pyramid – e-learning via map-server function requires reasonable material to be offered, skills of people that can prepare the materials and facilities for high end creation of spatial data. The readiness of people (possible learners) to use the material is also very important. Therefore, much of the service offered through the map-server is related to different familiar to ordinary users’ material: maps from EGCD, Estonia’s environmental monitoring atlas, linguistic and cultural materials from Finno-Ugric studies etc. There are similar projects carried out by other universities, e.g. using ESRI’s MapCafe Java applet at client side (Curtis et al., 1999; Theobald et al., 1999).

At viewers’ level, an additional map server, which, however, is in accordance with study programmes and practice exercises, can be regarded as the result of SAAGIS. Possibility (and a need during some exercises) to upload own maps gives learners another chance for interactivity that we foresee to be useful on advanced study levels. For student exercises, several other map servers are used as well, including some with higher analytic capabilities, e.g. ArcInfo8 Viewshed Demo from ESRI (http://maps.esri.com /scripts/esrimap.dll?name=renderer&Cid=Map). The main problem for us is, that such a server-side technology does not give us (without extensive Java-programming) enough functionality for teaching users. Since most of the students are not able to buy a desktop GIS for home computer, we try to use demo (and trial) versions of software; however, practical tasks to be carried out in classrooms (or working sessions for distant learners) are also unavoidable.

Map servers are one of the learning tools in the learning environment for which we introduce WebCT (instead of just putting study resources on a web site as we have done so far) inside of university’s virtual campus. Web Course Tools (http://webct.com/) offer many additional tools to individualize and diversify the study process.

As said before, our special attention will be on teenagers and therefore we will offer e-learning modules of an “Understand the World and its problems with GIS”.for the interested students.

There are pupils’ contests (Olympiads) in many school subjects, up to the world level in sciences. Why not to do it in geoinformatics? There is more than thirty years’ tradition of geography Olympiads in Estonia. It is time to add the computer geography to memorizing, describing and fieldwork geography. So, our next step will be to initiate a contest among pupils interested in GIS in order to stimulate the best ones.

Discussion

There are three classic debates in GIS: the vector-or-raster, the education-or-training, and the server-or-client-side-solution.

The first one remains in early years of GIS; by now the combined use of both is essential.

The second debate, concerning teaching GIS, is as follows: should it be ‘education or training’ (also
paraphrased as ‘about GIS or with GIS’, ‘GIScience or GISystem’, ‘methodology or toolbox’, etc.

Certainly, it concerns complementary activities and the real question is in what proportions should be 
‘theory and practice’ for a certain category of learners. While these proportions are more or less settled 
for traditional university curriculum, it is still under discussion for school level. Should polygons and 
overlays as the computational geometry be part of mathematics; or should different (spatial) queries as the 
database applications be part of informatics? What about computer graphics (a CAD to draw, a photo 
editor for image processing)? Which school subject should include remote sensing? Maybe next reform of 
school curriculum will introduce technology as a subject, complementary to science, ICT being an 
organic component of it?

Another related question is about motivation of students to learn and use different GIS solutions. 
Forceful inclusion of GIS into school curricula aiming at making all students GIS users may not give the 
aimed results, further, it may not be needed. Technical ability to use GIS as an environment for learning 
something is not enough as the most important task is not getting some kind of spatial picture (a map?) 
done, but understanding what it means. True interpretation requires ability to understand what do spatial 
relations mean in the real world. Maybe learning from the good examples of spatial decision-making 
(environmental conflicts’ resolution, city planning solutions and misconstructions) will help to understand 
geography, just like reading and analysing of good novels helps to learn of language and literature?

The third debate is similar to the previous ones: the real question lies in the proportions of the server-
side and the client-side functionalities. The hardware – home computer – of an end user is powerful 
enough to do almost any analysis necessary for educational purposes. Next requirements – software, data 
and know-how – should find their solution by means of web technologies. Today’s considerable 
limitations in software and data are related to costs and copyrights. However, the question of the 
proportions between the thickness of server and client is much related to the general ability of the users 
community to utilize the material. A situation where there is a possibility for each user to choose the 
suitable ‘level’ fitting one’s needs and readiness could be considered as ideal. This would also facilitate 
step-by-step learning and thus moving towards more sophisticated use of the GIS environment. Also, it is 
not just the question of the development of the technical GIS skills but it is even more about 
understanding data and finding relevant interpretations. This relates the discussion of proportions to that 
of learning or training.

Attitude to spread spatial data is different in different cultures (states). How much will (should they?) 
developments in European GIS infrastructure shape the common understanding on GIS education? 
Will it move to the cooperation, to the coordinated curricula, to the standards?

The previous EUGISES seminar pointed out several discussion questions (e.g., Bakker and Bakker, 
2000; Reeve, 2000; Strobl, 2000), some of which are still topical and debatable. It shows that two years is 
indeed a long time for ICT development, especially concerning networks and web technology, but a short 
period for most of the methodological problems.

Conclusions

e–Learning is both topical and promising for education in geoinformatics. Advantages of e–learning 
can be utilized better, if user levels are taken into account. The well-known division of doers–users– 
viewers enables to define general properties of learners’ groups. According to the potential number of 
learners in each group and their expectations to the study material the education of doers should be 
offered in European level. The users’ education should combine internationally prepared materials (in 
English) including local data and analyses of familiar spatial problems. The viewers need native study 
guides, which are of top priority for a small country like Estonia, because they can not be substituted 
with something else.

In Estonia, our special attention is on advanced pupils – on the so-called Tiger Leap generation – as the 
potential leaders among eCitizens in near future.

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