Designing a course of geoinformatics for secondary schools: a conceptual framework

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Abstract

A set of study materials for the course of geoinformatics has been offered by the Department of Geography, University of Tartu as an optional for upper secondary schools in Estonia. The subject will be flexible and multilayered to support students with different interests; practical exercises form the basis of study. Testing of the new materials is to be carried on during the next school year.

1 Introduction

On January 2010 the Government of Estonia approved the updated National Curriculum for Upper Secondary Schools. It lays more emphasis to optional subjects. The domain of science and technology includes besides robotics, applied programming, elements of economic mathematics e.a. also a 35 hours elective course of geoinformatics. The Operational Programme for Human Resource Development financed through the European Social Fund is supporting the development, piloting and implementation of courses' teaching/learning infrastructure. Geography department at the University of Tartu (UT) is responsible for creating such an infrastructure for the course of geoinformatics. In current paper we will present and discuss conceptual framework for this task.

2 Educational background

Position of geography in the school education is changing at times in many countries, and not always favourably for geographers' ambitions. Curriculum issues have been discussed several times, for upper secondary school by Reinfried (2001; 2004), Tabulawa (2002), Firth & Winter (2007), and for the Baltic States by Liiber & Roosaare (2000). Development of information technology (IT) has been seen as one of the main influencers in education introducing multimedia and e-learning environments. For geography IT found its expression in wider and wider use of GIS. It came from limited number of professionals using Arc/Info in 1980ies, grew to millions of browsers of geodata in 1990ies and embraces now via Web 2.0 based solutions like map servers, WMS, WFS, and mash-up almost everybody using internet. Nowadays, it would be difficult to find a secondary school pupil who has not used Google Earth. Computer-based spatial literacy is a natural component of school geography education today and has many good practices (Donert 2010; Jekel e.a. 2009; 2010). Also, explicit inclusion of GIS into school curriculum takes place, e.g. in Norway (Rød e.a. 2010).

A model of teaching geography we consider to be suitable for a small country like Estonia emphasises importance to stimulate advanced scholars' activities to penetrate deeper into a subject area (Roosaare e.a. 2007). The need for special attention to gifted pupils is stressed also by the new Curriculum. For that purpose the Gifted and Talented Development Centre at UT is in use and international Olympiads are one of the stimuli (Liiber & Roosaare 2007). Since 2005 courses on geography included simple spatial data query, analysis and mapping exercises (using ESRI's AEJEE and map server of Estonian Land Board), but in 2009 a course of ArcGIS started, where both teachers and pupils participated together. Moodle as the learning environment is in use. It is quite common now also for secondary schools to use both e-learning and eKOOL (a centrally hosted web-based school information and management system – https://ee.ekool.eu/index_en.html).

Requirements for courses included in the domain of science and technology oblige us additional to the geography traditions also to follow conventions of informatics and to realize, that part of potential participants in the course of geoinformatics would be computer and programming fans.

3 Conceptual pillars

Taking into account curriculum requirements, real situation in schools, good educational practice and our understanding of spatial literacy the following benchmarks are set up:

- **Practical orientation**. The course should be oriented towards forming working skills of compiling and using geospatial data to solve geographical problems. Majority of the study kit consists of practical exercises to be solved in groups or on one's own.
- **Stratification of material**. We foresee that this course will be elected by students with different interests, different basic knowledge (especially in computer literacy) and different learning objectives. Therefore, both theoretical material and tutorial exercises will be presented in several levels of difficulty. The basic level assures fulfilment of learning outcomes as required by the National Curriculum. Linkage of material and suggestions in the teacher's aid will help to manage levels of difficulty and direct students' interest towards feasible problems and solution tools (up to professional GIS software) what is important for holding high students' motivation. For stratification we make use of experience with an electronic textbook (Liiber & Roosaare 2005).
  e-learning environment offers technical solutions for material stratification. During the turning of the course each teacher shall individualize his/her course making choices via Moodle's settings, which materials, assignments, forums etc. for which students and when are open.
- **Flexibility of timetable**. All materials are presented in the MOODLE environment enabling also partial or full e-learning. Time and place of consultations are not fixed to school.
- **Flexibility in study groups**. One of the possible risks for an elective course like geoinformatics is that in smaller schools the number of interested students in a particular year may not be big enough to form a study group. Also, in some countryside schools the teacher's side competence may be limited, especially if an aged geography teacher will meet with students' advanced interest e.g. in 3D

modelling. Therefore we propose that it should be possible to make up study groups consisting of students from different schools and being supervised by a good teacher. Such a scheme is justified by the practice of the Gifted and Talented Development Centre at UT, but for schools it needs legal and financial regulation by the Ministry of Education and Research.

- **Integration with other subjects and everyday life**. Assignments to use are connected to home place (e.g. mapping of student's way to school or the activity space; doing it on the orthophoto or using GPS; measuring results by cartometric tools or analysing by routeplanner etc.). Exercises testify to the benefit of knowledge in geography (and *vice versa*), math, history, physics. In addition, geoinformatics promotes also english, even gym (orienteering as a recommendatory fitness activity in Estonia).
- **Problem-based learning**. The teaching should start from simple, intuitively self-explanatory practical questions. Thereafter limitations of found solutions and tools in use are pointed out and a need for additional theory is explained. The acquisition of new knowledge will enable to set up more complicated questions, apply new tools and solve next assignments.
- **Flexibility in software and data using**. We start with web map services and ArcGIS Explorer, and then continue with Quantum GIS. Possibility of using campus licenses of commercial software is under investigation. The course uses data from public web sites and specially prepared tutorial data.
- **Perspectives for professional career**. Connectedness to the profession choices and questions of employability are emphasized as important aspects of elective courses by the National Curriculum. In addition to presentations in the study materials, it is possible for advanced students to join with email lists and social networks of geoinformatics community. Also, it will be possible for advanced students to complete the course on that level, which enables to count it (by the Accreditation of Prior and Experiential Learning Project) for university level credits.

4 Course infrastructure

The course itself will be based on Moodle's learning environment, but there are also several supporting structures (Fig. 1), which make use of existing and conventional information channels.

5 Contents and organization of the course

We foresee the following 6 modules:

1. Components and application areas of GIS (5 hours: 3 practical exercises; 1 interactive lecture; 1 seminar).
2. Spatial data and databases (7 h: 1 outdoors studying; 5 practical exercises; 1 seminar).
3. Georeferencing (5 h: 4 practical exercises connected to each other with short – 10 min

– video lectures; 1 seminar).

4 Queries from GIS (7 h: 6 practical exercises; 1 seminar).

5 Thematic mapping (5 h: 4 practical exercises; 1 seminar).

6 Solving a problem (5 h: 4 practical exercises; 1 seminar).

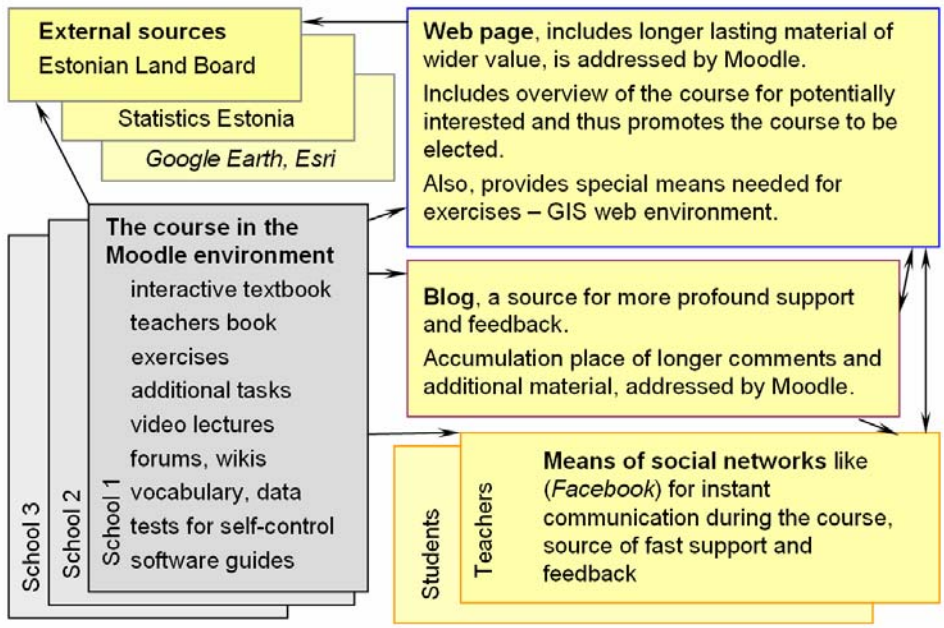

Fig. 1: Web-based learning infrastructure for the upper secondary school elective course "Geoinformatics".

It makes altogether 35 hours, ¾ of which are dedicated to hands-on activities with geospatial data and software using tutorials what enable individual work (homework as well). Assessment will be based on the answers of electronic test questions and on uploaded by pupils files what are peer-reviewed and commented by the teacher in Forums as well as later in the seminars. The latter consists of students' presentations, teacher's feedback and introduction to the next problem.

Possible assignments are exemplified for the case of module 4:

- select regions satisfying given conditions (e.g. parishes where the *X* party won in local elections);
- route queries (e.g. find a route through the selected points of interest) and critical analysis of results;
- description of regions (e.g. Estonian counties by birth rate, by increase/decrease in population; by distribution of population or enterprises) and visualization of results

(will be criticised and further developed in the next module);

- different ways of defining proximity (e.g. how many countryside people are living close to the cities?);
- selections by themes (e.g. to find differences in landcover structure by catchment areas);
- queries using map algebra (e.g. how to find suitable areas for camping);
- what–if queries using server-side modelling (e.g. changes in school network of Estonia depending on changes in population and in the rules of schools' opening/closing).

The last module – Problem solving – includes a choice of an individual case, which is further elaborated by means of more general guides. Students will ask enquiry questions, gather data, analyse them in order to find answers and present their solutions as thematic maps.

6 Problems of implementation

To realize the above-described framework a team (10 people with part-time involvement) is formed. According to rules of the Ministry of Education and Research it includes experts of geoinformatics, didactics, e-learning, multimedia, project management, as well as experienced school teachers. Pilot schools to test our production include 4 secondary schools, one of them from the Saaremaa Island and one from Narva, where students' mother-tongue is Russian. Deadline to finish the project is March 2013. Although for developers this time seems very close, in the world of IT with its rapid developments for three years probably new computers and new versions of software will come out. As one of the risks we foresee that user interfaces may have not only some cosmetic changes, but also more conceptual ones (like shapefile →geodatabase earlier). This suggests that learning materials should be as software-independent as possible and an ideal teacher should be able to customise guides of tutorial exercises. Taking into account how easily kids acquire computers' 'mental life' by the intuitive learning – contrarily to the instruction-based learning of elderly people – we should consider how to make our guide more intuitive. Because pupils of 2015 do not have memories about old times without mouse and internet.

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