GIS and Cartography at DGUC

Short report from an education development project

GIS: Just a technical tool for geographers
- or a didactical instrument for developing geographical concepts as well?

Introduction

In fall 2005 an education development project was initiated with teachers of the introductory course 'GIS and Cartography' at the Department of Geography, University of Copenhagen (DGUC) and researchers from The Centre for Science Education, University of Copenhagen.

The purpose of the project was:

- to investigate and document didactical perspectives by integrating the introduction of GIS with the introduction of fundamental geographical concepts and competencies and
- to identify and describe problems in the ArcGIS 9.1 user interface which are restricted to the learning process of the students.

The course in GIS and Cartography recruits yearly approx. 100 first year undergraduate geography students and is alongside an introduction to human and physical geography the first subject the students meet when entering the university. The course gives (as the title indicates) an introduction to central elements within GIS and cartography. Focus is on how different abstractions of the world can be represented within a GIS by use of different data models. This is combined with hands-on laboratory classes situated within themes of human and physical geography using ArcGIS 9.1. The students are tested on their theoretical knowledge of GIS and cartography at the end of the course in a written exam based on knowledge achieved from a GIS textbook and their understanding of the lab exercises.

Back in 1988 GIS and remote sensing was offered to the students as two voluntary courses at DGUC. Both were technically oriented and located at the MSc level. Over the years more and more specialized courses concerning GIS have occurred and the introductory course to GIS has been moved further and further down to the BSc level. Finally, in 2002 the introductory course in GIS was merged with a course in cartography and placed as a mandatory course to all first year geography students. It provides the students with an introduction and first hand experience with GIS and is supplemented with six voluntary GIS courses placed further along the geographical curriculum.

As a result of an invitation from Assoc. Prof. Thomas Balstrøm, who is in charge of the course, the Centre of Science Education became involved in the education development project concerning this course. Thomas Balstrøm has many years of experience with teaching in GIS using ESRI's software. Even though he finds that using ArcGIS in introductory geography courses for first year students has a lot of important didactical perspectives and possibilities, he has also experienced some profound problems concerning this (Toft and Balstrøm, 2004). DGUC has made the choice to introduce the students to the same GIS software (ArcGIS 9.1) as used by the researchers at the Department of Geography. This contribute to the students' experience that GIS is 'the real thing'

with practical relevance for their future studies and professional careers. Though, to novices it is not that easy to become a confident user of software developed for professionals. Some of the problems are due to the complexity of the software and the rather frequent change to new software versions that forces the teachers and their curriculums to be updated continuously from release to release.

During the project it became more and more clear, that the students had quite different learning strategies, and that these have a great influence on the way they worked with the software in the practical exercises and how they build up knowledge and competencies. The main focus on developing a better integration of GIS and the development of geographical concepts has to be on how the students can be activated and involved in creating knowledge, and reflecting on how the GIS exercises relate to central theoretical issues. Even though the technical aspects of the software give rise to certain problems and that a more intuitive software might enhance the students learning processes, it would not be sufficient to ensure optimal learning processes for the students.

Methods and data for the project

Through interviews, tests, and questionnaires we created an understanding of how the students learn GIS, and how they establish links between their practical GIS skills in using ArcGIS and their theoretical knowledge of geographical and generic GIS concepts. The results were used to inform the current teaching practice within the course at DGUC. Furthermore, it has been used in considerations of how knowledge of students' GIS-learning strategies can be used to adjust GIS used in education. The project in its full length is described in Madsen and Holm (2006) where many subjects of importance for the development and planning of the first year courses in DGUC are treated. Furthermore, Madsen (2006) discuss GIS learning strategies and gender differences found in the project. In this present short report we focus on those subjects we find of central importance for a more general discussion on the use of GIS software in higher education and the didactical and pedagogical discussion related hereto.

Our report is based on the following empirical material:

- Participatory observations (25 laboratory classes in computer exercises, 3 lectures)
- Interviews with the 3 teachers involved in 'GIS and Cartography'
- Interviews with students (6 interviews with in total 9 students halfway through the course, and 8 interviews with in total 15 students after examination)
- Interviews with the student instructors in 'GIS and Cartography' (available 6 hours per week at off-class hours) and the other introductory courses of geography.
- Questionnaire (62% response rate, in total 49 students).

The students' learning strategies have been studied in relation to the specific GIS course focusing upon what kind of strategies are used to learn GIS and how these strategies are linked to the way the course is taught. The typology of learning strategies is developed by giving the students open questions in a questionnaire and afterwards categorizing their answers into types reflecting the different descriptions of how they have e.g. learned GIS. This is done both in relation to the students' descriptions of how they have learned GIS and to their advices to others who are going to learn GIS. Learning strategies is seen as flexible and constantly constructed and re-constructed by the individual student in relation to the teaching practice they meet both in the different courses and at the university as a whole. Interviews and participatory observations are in this part of the study used to reflect upon the found types of learning strategies.

The course on GIS and Cartography

The course is mandatory, has a duration of 9 weeks and consists of two weekly lectures (each of 45 minutes) combined with two weekly, two-hour computer laboratory classes. The laboratory classes with approximately 18 students each are given by the lecturers of the course. The students are placed in four different classes and work in pairs at the computers. Parallel to this course GIS is used in the contemporary introductory course in human and physical geography and, besides the later voluntary courses in GIS, also part of several later courses in both human and physical geography alongside the geographical curriculum. So, the course in GIS and Cartography should provide the necessary basis for the students to use GIS to solve simple geographical analysis problems defined at the parallel courses. Thus, no mandatory home work is actually scheduled for the GIS and Cartography course. The class labs are timed so the students should be able to finish their work when leaving the lab. However, the curious and eager student may explore a number of 'think yourself' exercises in the lab at off-class hours or at home as ArcGIS kindly has been offered to the students for home installation at the ArcView level.

Generally, we found that the course – and the subject – was highly appreciated among the students. Even though not all of the students to the same extend are fascinated by GIS and its possibilities, they all see GIS as an integrated part of their geographical education and important for their chances of getting a job after graduating. An example from our interviews shows the typical positive attitude:

'It has been more fun and more interesting that I thought it would be. It is a very valuable tool in our information society'.

In the lectures the fundamental concepts and problems of the course are presented and the course is planned so that the GIS exercises in laboratory classes every week correspond to the content treated in the lectures. The GIS exercises are described in a 'manual text' of 150 pages, authored by the course teachers over the last years. They are continuously ensuring that the text is always updated to the latest version of ArcGIS which is a time-consuming job. To ensure that the students are able to solve the exercises using the relevant GIS functionalities the text is very thorough with all the steps in the exercises described and illustrated with screen dumps.

In order to investigate the activities in the classroom we have observed the number and kinds of questions during four laboratory classes (two different classes of students, b and c, doing two different exercises). As shown in Figure 1 most of the questions are regarding problems understanding the user interface of ArcGIS 9.1 and other technical questions.

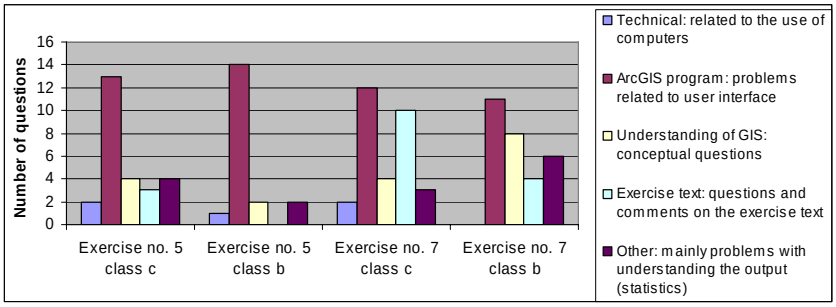

Figure 1 Categories of student questions in laboratory classes

Despite the attempt to minimize problems concerning the use of the software through the comprehensive exercise text, we see that the main part of the dialogue between teachers and students is used answering technical questions regarding the ArcGIS 9.1 user interface. Questions and discussions involving the teachers are limited on topics reflecting the concepts and problem solving strategies involved in the exercises.

Even though the students are actively involved in the computer exercises, they are not necessarily actively involved in creating the important links between the topic of the exercise and the topic of the lectures and textbooks. When we asked the students half way through the course, only a very few of them did actually prepare themselves for the lectures. Most of the students had decided not to read the theoretical textbook until the last weeks before the exam because of time pressure from other courses and they didn't find that reading was necessary to solve the GIS exercises. At the end of the course a student expressed a possible result of a non-reflecting approach to the exercises:

It becomes boring when you don't understand what you are doing, and that happens when you are not forced to think.

It doesn't mean that none of the students do think for themselves and seek deeper understanding, but it does depend upon the individual student's learning strategies. The results from a test and the interviews show that the planned links in the content of lectures and exercises are not automatically transferred to corresponding links in the students' conceptual understanding.

Students' strategies of learning GIS

From the interviews and observations it became clear, that the students had quite different approaches to learning. In the questionnaire we asked the students to describe how they had learned GIS emphasizing a focus on what they had actually done rather than what they thought they should have done. Based on their descriptions we were able to distinguish five different types of learning strategies among the students. These are shown in figure 2.

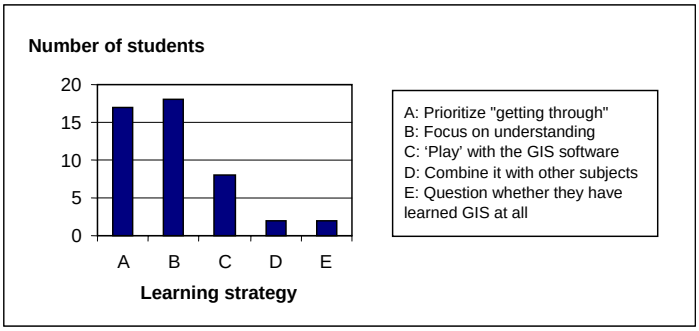

Figure 2 Different GIS learning strategies of the students

Three types dominate the picture namely type A, B and C, whereas type D and E was almost non-existing. Type A is students who prioritize 'getting through' all the literature, exercises and lectures, type B is students who prioritize understanding in their approach to GIS, and type C is students who prefer playing with the ArcGIS software in order to learn GIS. Type D students indicate that they learn GIS when they use it in the parallel courses in human and physical geography. Finally type E

students questions whether they have learned GIS at all. In the following, examples of the three main types are given:

Type A student: *'I attended the lectures, wrote notes and printed out the hand-outs. Before exam I read all the assignments including the hand-outs. I made notes so I had an overview of the different concepts and expressions. I wrote down where in the assignments the different concepts were defined. I did markings in the texts and made tables of contents to the texts that we did not receive tables of contents for. I put the texts and notes in a briefcase organized in accordance with the lectures. I attended all the classroom exercises and the ones that we didn't finish in the labs we made sure we finished them during the week'.*

Type B student: *'I went to both the lectures and the labs. In the labs I focused on understanding what we where doing and not just go along* [and finish the exercise]. *I read all the course assignments, however only once…. I sat down in the exam preparation period and discussed different topics with the other students'.*

Type C student: *'I sat down for many hours with ArcMap/ArcCatalog both at home and in the labs. That's given me a pretty good overview to understand what the lectures were about'.*

It is important to consider how the students learning processes can be supported regardless of their GIS learning strategy. Those aren't static categories but are to some extent influenced by the planning of the course and by ArcGIS 9.1 as well. A student of type A will focus on finishing the task instead of understand the meaning of the task. If the student should be able to develop GIS competencies to be used in other contexts as well, understanding and reflection is crucial. It becomes of importance to formulate the tasks so that reflection is a central part of the task. Type B and C are both minded to use the software in a reflective way to develop their understanding of theoretic issues in the course. Our study shows that it might be an idea to encourage students' 'playing with the software' and other kind of independent explorations.

If we look at the gender differences in each of the different learning strategies (figure 3) it can be seen that within type A slightly more women than men prioritize 'getting through'. More distinctly, it can be seen that also more women than men seek understanding (type B) and further that more men than women learn ArcGIS by playing (type C).

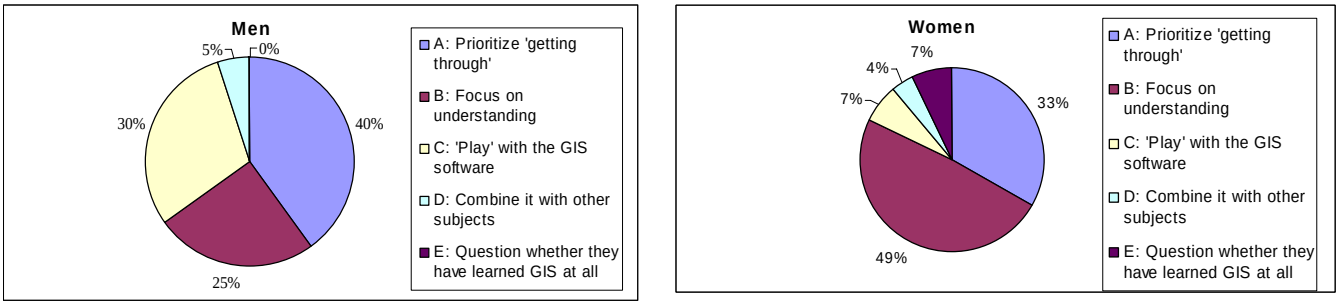

Figure 3 GIS Learning strategies – men and women

Also in the exam results we found gender differences depending on the type of questions. Further studies are however needed to expand on our knowledge of this subject.

Students perceptions of ArcGIS

As mentioned earlier, none of the students questioned the value and relevance of GIS in geography education. In the interviews we asked the students to characterise ArcGIS 9.1 and address what they found difficult and problematic. Surprisingly, many of the students told that they didn't find any specific difficulties which were in contrast to the experience from our class observations where lack of understanding the user interface was dominant in the questions asked. But the students haven't really experienced any problems because they had both the teacher and the very descriptive exercise text to prevent them from experience any difficulties. They could complete their exercises, understanding the meaning or not. Though, there were a few functionalities they did comment on, which can be supplied with our observations in the labs as well. The students are part of a 'Windows generation', which means that as long as a software is in agreement with the standards of Windows the students have a extended intuition, and else not.

For standard procedures like file administration, however, there were some fundamental problems. The students found it very difficult to distinguish between 'Open Map Document' and 'Add Data', and it wasn't even clear to all of them at the end of the course what was the difference. Most of the students found it very contra intuitive that opening a document by 'open' didn't give access to adding data.

Also, they found it hard to distinguish what was central to the structure of the software and what were extra features for specific applications. Too many choices were to be made even for a standard use of a feature. It might be preferable if there were more default settings, where the students didn't have a dialogue box only if they wanted to change these settings.

It could be difficult to the students to find specific functionalities and their names, placement and icons weren't always that intuitive within the standard UI. The students specifically mentioned the spatial analysis functionalities as a problem.

Generally, this problem seems to originate from the fact that the software is very big and complex where the logical structure not always is obvious, nor to say intuitive, to the user. When the functionalities are getting just a little bit complex it is very hard for the students to work with the problems on their own and partly because of their lack of software overview they don't know where to start. The 'help' functionality is crucial in respect to that and it needs at least to be quick, accurate and with good searching facilities. And the problems regarding the 'help' functionality in ArcGIS 9.1 are the most significant. The students in this course more or less gave up using the 'help' functionality in the software and depended on assistance from the teachers and fellow students instead. It was later discovered by the course responsible, Thomas Balstrøm, and Ashley Pengelly, ESRI, that an extremely slow performance of the Help-functionality is (still!) caused by an immense check of every Help item opened by the departments antivirus software in use (McAffee).

Strategies for developing GIS as an instrument for learning geographical concepts

It has been argued that the role of GIS is currently changing (Madsen 2006). Educators increasingly perceive GIS as a geographical instrument educating the students in spatial thinking (see e.g. also

National Research Council, 2006) rather than just a technical tool expanding the toolbox for geographers. It can be described as a turn from the role as a technical supplement to the geographical curriculum towards a new role placed right in the intellectual core of geography. As a result GIS is increasingly becoming a geographical instrument through which students learn central geographical concepts such as e.g. spatiality and scale. This new role of GIS creates a wish for a development of the software towards a more clear structure, which would make it easier for novice students to manage the software – and for the skilled researchers as well. There shall be room and opportunities for 'playing with the software', and the more the software can be intuitively understood, so that the students themselves can explore the structure of the software, the better. In that way they can focus on problem solving in geography using GIS as a fundamental methodology, instead of focusing of the computer technicalities of the GIS tool.

At the interviews after examination we met a few students that really managed to use their knowing of ArcGIS and their hands-on experiences from using the software as an instrument to support their conceptual understanding of geography and adding meaning, when reading theory. We find that GIS has a great potential in that respect to be not just a tool, but an instrument of understanding geography and supporting the students learning of generic GIS concepts.

References

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