Problem Based Learning in Geoinformation: Approach, Examples, Experience

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Abstract

One major characteristic of the curriculum at the School of Geoinformation at Carinthia Tech Institute (Fachhochschule Technikum Kaernten) in Villach is project-based learning (PBL). PBL is performed in form of *Project Work* modules in the first 6 semesters of the study, on average one day per week. Each *Project Work* covers one GIS-related topic providing students with necessary theory and hands-on experience. Working on real tasks with real *contractors* and interdisciplinarity are major properties of our PBL-approach. Web GIS, GPS-technology, Geomarketing, Cartography or GIS-application development are topics covered so far. This paper will report about our experience with PBL and show current results.

1. INTRODUCTION

The School of Geoinformation (SGI) at Carinthia Tech Institute offers an innovative GI-curriculum that is designed to meet the needs of technological advances in industry. The problem or project based learning approach is incorporated to provide optimal learning environment for the students. Problem based learning (PBL) is commonly understood as a learning environment that supports acquisition of different skills. The concept of student-centred learning is central to PBL. The University of Maastricht with its long-term experience in PBL describes the objectives of this method as "…to overcome the various drawbacks of traditional instruction methods, where students have passive role during lectures,… disciplines are not integrated, … and most importantly, graduates are not trained to apply what they have learned in practice (cited in (Pester, Ofner et al. 2002); http://www.unimaas.nl/pbl/). PBL is a way to foster thinking and critical analysis and provide real focus or understanding of the objectives of the curriculum for both students and staff, which traditional curricula and rarely do (Shanley and Kelly; Pester, Ofner et al. 2002). Traditional view of teaching and learning is characterized by frontal instruction and often results in inert knowledge. Inert knowledge is defined as knowledge a person can reproduce but often has difficulty to apply it to a specific problem (Kopp and Mandl 2002). According to the constructivist view (Mader and Stöckl 1999) a learner is in a self-active position (student-centered learning and teaching) whereas a lecturer offers situations and tools to solve problems, and acts as coach and advisor. This approach helps prevent inert knowledge.

We have developed and implemented the curriculum for geoinformation students at SGI since 2000 following the Proposal guidelines. The guidelines provide a means to overcome the shortcomings of the traditional curriculum as well as traditional teaching and learning methods for engineering students. The curriculum foresees that on average one day per week in the first six semesters is dedicated to a project work. Interdisciplinary teaching, practice orientation, intensive use of both German and English, and application of soft skills on a day-to-day basis are central to the study of GI at SGI.

This paper focuses on the approach and experience to PBL at SGI. The structure of the paper is as follows: first the curriculum is presented. The actual approach is described and illustrated by examples of project works performed at SGI. The paper concludes with a summary of our experience and ideas for improvement of current practice.

2. FRAMEWORK: THE CURRICULUM

The School of Geoinformation (SGI–*Fachhochschulstudiengang*) was established in July 2000 (http://www.cti.ac.at/geo) . This course of studies takes 4 years or 8 semesters. The total number of teaching hours is 160, or the equivalent of 240 credits (ECTS). Graduates from SGI are geoinformation engineers (Dipl.-Ing.(FH)). The first graduates are expected to leave the school in summer 2004.

The guidelines for creating the SGI are defined in the Proposal, the accepted application for a study program accreditation in Austria (so called *Antrag* (Kaernten 1999)). They include e.g. curriculum, its educational goals, teaching principles and practice orientation (for more details about the School see (Car 2002)).

The main study areas are presented in figure 1:

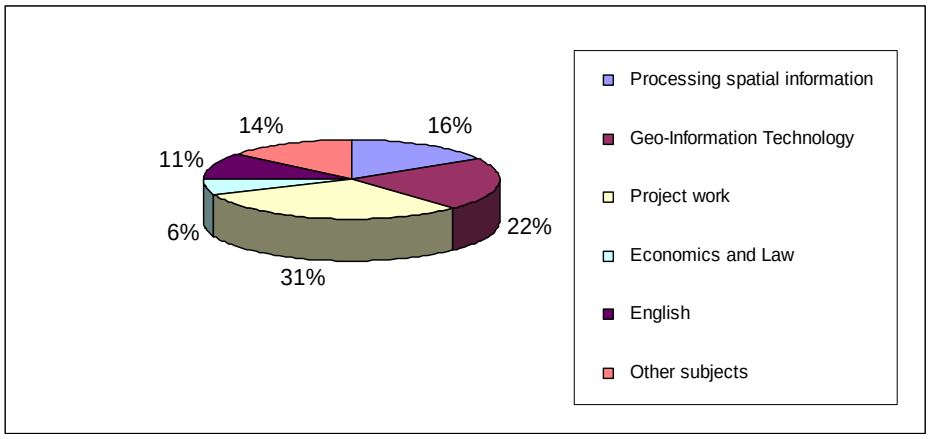

Figure 1: Main study areas of the curriculum at SGI.

The educational goals of the curriculum are:

- Knowledge transfer, which includes spatial data / knowledge processing, Geo-IT, business, law, and management;
- Acquisition of skills such as rhetoric, presentation skills, academic writing, team work, and communication;
- Language competence in both German and English.

In general, each of our graduates is expected to either work independently and run smaller projects or be a valuable team member in a big project.

According to the Proposal guidelines (Kaernten 1999, Section T) the teaching is expected to be interdisciplinary and mostly in English. Currently 19% of all classes are taught in English only, and 16% of the classes use both languages (figure 2).

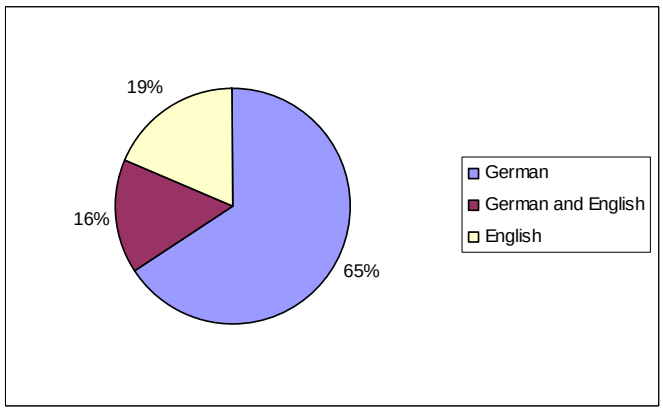

Figure 2: The percentage of the courses currently taught in either German and/or English.

Strong practice orientation is the main property of a course offered by a university of applied science (*Fachhochschule*). At SGI practical experience is acquired at three different levels: project work, internship, and diploma thesis. *Project Work* takes place in semesters 1-6. Students work on a project in teams of three to five usually 1 day per week. In each semester a different theme is covered offering the students both, practice and variety with the support of underlying theory. The process of designing and developing a GIS-application, Web-based GIS and server technology, GPS and GIS, geo-marketing or cartography, and map production, are some of the themes covered.

An i*nternship* (Berufspraktikum) takes place in semester 7. This internship is an integral part of the curriculum in which students experience real-world working conditions. During an internship each student will be assigned a project which can be completed in 5-6 months. Students are expected to apply their theoretical knowledge, technical know-how and expand their soft skills with the goal of finishing the project on time. The first generation of students is currently in the internship-semester. The list of all institutions providing an internship position is given in the Appendix A1.

Writing a *Diploma thesis* is necessary in the 8th semester. A student chooses or is assigned a topic of her thesis. Students are expected to show ability to work scientifically by producing a thesis that meets academic standards.

Project Work is where practice-oriented teaching, i.e. PBL takes place within the actual study time. The reminder of this paper focuses on our approach to PBL illustrated by the examples of the accomplished projects within the Project Work courses.

3. OUR APPROACH TO PBL

At SGI PBL is manifested two ways: (1) *implicitly* through various labs, integrated courses and seminars; and (2) *explicitly* through practice orientation (as described in the previous section). The implementation of PBL in teaching and learning at SGI adopts both the instructional and the constructivist view. The challenge though is to find balance between explicit guidance and support by a lecturer and a constructive activity by a learner (as suggested by (Kopp and Mandl 2002)).

Our approach to PBL emerged from a four-year experience in our own teaching as well as adopting successful ideas of highly advanced PBL from our neighbouring School of Electronics (Pester, Ofner et al. 2002). The approach is based on the following principles:

- *GI-relevant themes and freedom of choice:* Project themes are suggested by module leaders (professors at SGI or external lecturers), and are usually real-world problems with real users. Students can choose either among different project proposals or among different sub-projects within one big project. An example of project proposals is given in Appendix 2.
- *Team Work:* Project teams consist of three to five students. This team size corresponds to the real-world teams. Students have the freedom to organise themselves in groups and determine a team leader. Collaborative learning and various activities foster the team spirit, which in turn increases efficiency and guarantees timely completion.
- *Soft Skills:* We believe that skills like rhetoric, presentation techniques, and communication can only be acquired through intense and frequent practice. Project work 1 in semester 1 is therefore dedicated to basic training for soft skills. Students then practice these skills throughout their studies. The same holds for technical and scientific writing. The elements of writing are taught mainly in English classes but in conjunction with other courses where e.g. a project report or an essay is required. The first large writing project was undertaken in Project Work 2 in summer semester 2003, where students wrote a project report in English. The report was assessed jointly by English professor and the project leader.
- *Coaching* As previously mentioned in this paper, lecturers are coaches and facilitators rather than project leaders. Their role changes throughout the project: they introduce a project, help generate a concept and plan its implementation; then they switch to technical consultants in case problems arise.
- *Project evaluation:* The essential part of the projects is the project evaluation. The evaluation process consists of individual and team assessment. An example is given in the following section.

4. AN EXAMPLE OF PBL AT SGI

In the course Project Work 2 (PW2) in the 2nd semester students learn the process of design and development of GIS applications. Their task is to become familiar with the application area (e.g. through literature review and consulting specialists), design a concept for a GIS-application, and finally use the formal description of the concept as the implementation guideline.

The deliverables are:

1. an operational GIS-application (to show that the idea works)
2. presentation (20 Min. + 10 Min. discussion)
3. a report which describes steps and outcomes of the project
4. a poster presentation
5. a summary of the project (suitable for publishing on the web or as a handout)

The goals of PW2 are manifold:

- Exposure to the process “idea – concept – development” of a GI-product
- Learning about methods of modelling spatial concepts
- Application of already acquired knowledge in GIScience and use of software tools like ArcView and MS Access
- Soft skills
- Academic writing:

- Structuring and writing a technical report incorporating elements of scientific writing
- Working with literature and use of EndNote (a software to create and maintain a database of references, which works very well with Microsoft Word)
- Practicing of preparation and giving a presentation
- Design a poster

German and English will both be used in the course. The project report is written in English. Projects are presented at the end of the course and are open to the public.

The evaluation of the project work includes the following elements (the percentage of the total grade):

- 5% presence,
- 20% team work and collaboration,
- 45% presentations (group work) and
- 30% project report.

The evaluation of the team work is based on availability of the solution (Was the task solved in the first place?), the creativity of the solution, and quality of both the presentation and the report. Individual work of every team member is assessed through student's knowledge and competence, her contribution to the project presentation and the report, level of cooperation among students in the team, initiative and feeling for deadlines, as well as her general contribution to the team. The individual work is assessed by students themselves and contributes to the general grade.

A number of projects have been accomplished since summer semester 2001, when PW2 was first taught. For example, in 2001 one group of students developed a GIS for cave researchers and rescuers (SpeleoGIS) (Car 2000). In 2002 the task was to develop a GIS for sport and hobby divers (Car 2003). The most recent project in 2003 focused on design and development of a GIS for runners (figure 3a, see also Appendix A2). A concept formally described by an entity-relationship model and diagram and an object catalogue is used as a guideline for implementation. Applications were developed with help of the GIS software package ArcView 3.2 (www.esri.com) and used a Microsoft Access database management system to create and implement a database. All projects were entered in the poster competition at the AGIT conference in Salzburg (www.agit.at) and won 1st prize in 2001 and 2nd prize in 2002 and 2003 respectively (for example, the certificate received at AGIT 2003 is presented in figure 3b). Detailed descriptions of the students' projects can be found on http://www.cti.ac.at/geo/.

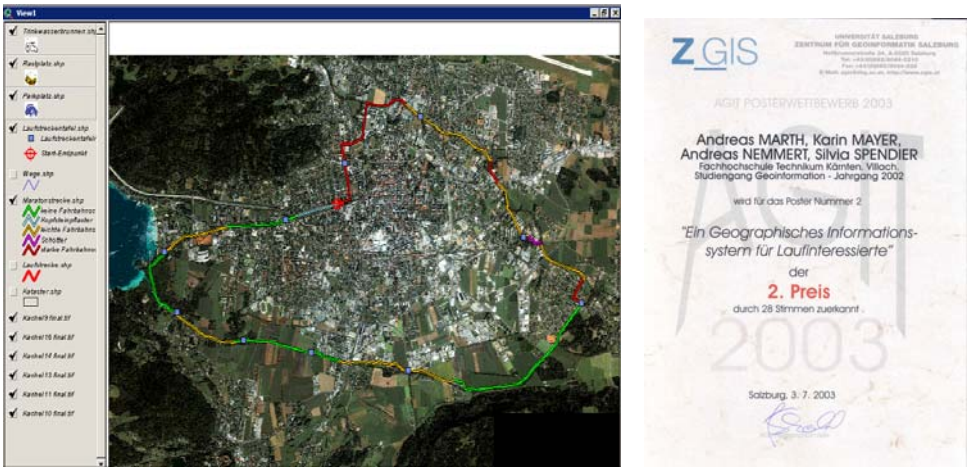

Figure 3: (*a*) The GIS for runners representing the half marathon trail in the City of Klagenfurt. (*b*) The corresponding poster wan the 2nd poster prize at AGIT 2003.

5. EXPERIENCE USING PROJECT-BASED LEARNING AT THE SCHOOL OF GEOINFORMATION

The SGI's three years' experience with PBL approach is encouraging. The lecture evaluations by students show that the large majority of them prefer project work because they like working in teams at their own pace and be responsible for their actions. Even though the students appear overwhelmed and "lost" when first confronted with the idea of such a project, they quickly adapt to the situation and show that they can cope with such a task… with a reasonable dose of coaching.

We identified authenticity as the main contributor to the success of our Project Work courses among students. *Authenticity* means solving real-world problems, dealing with real project partners and users, and using real data in a real GIS-environment. Major benefits of the PBL are:

- "*Springboard knowledge*" (Pester, Ofner et al. 2002, p. 389) – previously acquired knowledge serves as a basis for solving task at hand and insight into new information
- *Interdisciplinary approach* – knowledge from various disciplined is needed and used to solve complex problems
- *Deeper understanding* – the complexity of developmental work in GIS is mastered
- *Management skills.*

Finally, the foundations of critical thinking are established, which are developed further in the study.

6. SUMMARY AND FUTURE WORK

The project work courses in Geoinformation deliver attractive results both in terms of technical achievements as well as experience in applying problem based learning strategies. Students appreciate such a way of studying mainly because of the projects' authenticity and because it allows hands-on experience. It is our intention to increasingly combine the themes of our research with those of students' projects.

REFERENCES

Car, A., 2000. Bringing Speleological Data into GIS. In the Proceedings of GISRUK 2000, Glamorgan, UK.

Car, A., 2002. School of Geoinformation at Carinthia Tech Institute. In the Proceedings of The Third European GIS Education Seminar (EUGISES 2002), Girona, Spain. 4.

Car, A., 2003. DiveGIS: a GIS for Sport and Hobby Divers. New Orleans, LA, The Association of American Geographers, 99th Annual Meeting.

Kaernten, T. 1999. Antrag: Fachhochschulstudiengang "Geoinformation" in Villach.

Kopp, B. and H. Mandl, 2002. Problem-Based Learning in virtual GIS learning-environments. In the Proceedings of The Third European GIS Education Seminar (EUGISES 2002), Girona, Spain. 5.

Mader, G. and W. Stöckl, 1999. Virtuelles Lernen. Begriffsbestimmung und aktuelle empirische Befunde. Innsbruck, Studien Verlag.

Pester, A., E. Ofner, et al., 2002. Problem Based Learning in Microelectronics: Approach, Experience, Examples. In the Proceedings of Probleme und Perspektiven der Formung einer nationalen technichen Elite (Teil 2), Harkov, Ukraine. 387-389.

Shanley, D. B. and M. Kelly Why problem-based learning? http://www.odont.lu.se/projects/ADEE/shanley.html.

APPENDIX A1: LIST OF INSTITUTIONS OFFERING INTERNSHIP POSITIONS IN 2003/2004:

- Companies
  - traffic information and management GmbH (D)
  - Orbisat da Amazonia S.A. RS Division, Brasil
  - Intergraph (D)
  - WiGeoGIS GmbH (Wien)
  - Umweltdata (Wien)

- Local Authorities
  - Magistrat Klagenfurt (3 students)
  - Magistrat Villach
  - DORIS (Amt der Landesregierung in Upper Austria)

- Organisations
  - World Wide Fund For Nature (WWF)–Aueninstitut (D)

- Academic institutions
  - TU Wien (Prof. A. Frank)
  - Uni Bundeswehr München (Prof. W. Reinhardt)
  - Louisiana State University, Dept. Geography&Anthrop.(Dr. Leitner)
  - Curtin University of Technology, Spatial Sciences
  - School of Geoinformation and Austrian National Forestry (Bundesforste)

APENDIX A2. AN EXAMPLE OF A PROJECT PROPOSAL PRESENTED IN THE COURSE "PROJECT WORK 2", SEMESTER 2 (SUMMER SEMESTER 2003)

Sport and Outdoor GIS for the city of Klagenfurt

The Klagenfurt area offers a broad variety of sport and outdoor activities for its citizens, visitors, and tourists. This project focuses on running and biking: routes and infrastructure in support of these activities.

Goals and outcomes:

- Design a conceptual model of a GISystem for running and biking
- Develop a prototype of a GISystem to justify the concept

Users:

- City employees responsible for maintenance and management of these facilities
- Citizens, visitors, or tourists as users of facilities

General framework:

The prototype can be a stand-alone GISystem, but It should expand the existing Klagenfurt-GIS and its accompanying website.

Contact persons:

Günter Koren – responsible for the digital city map of Klagenfurt, MA Klagenfurt

Literature and information sources:

www.info-klagenfurt.at
www.klagenfurt.at
www.tiscover.at

Project documentation about the Klagenfurt-GIS