Teaching Geodata Acquisition – E-Learning Experiences and Sustainability

Volker SCHWIEGER and Thilo KAUFMANN, Germany

Key words: Geodata acquisition, E-Learning, GIS, WebGIS, Evaluation.

SUMMARY

For successfully running Geographic Information Systems (GIS) the required geodata has to be acquired. For this task different techniques of primary and secondary acquisition methods may be used. The knowledge regarding these techniques and the required basics is valuable not only for geodesists but for all GIS user. Hence these techniques are taught at the Institute for Applications of Geodesy to Engineering (IAGB) University Stuttgart to other courses of studies like technique and management of real estate (in German) and infrastructure planning (in English).

The e-learning project gimolus (GIS- und modellgestützte Lernmodule für umweltorientierte Studiengänge, i.e. learning modules for GIS and modelling in environmental courses) granted by the German ministry for education and research gave the opportunity to create e-learning modules for teaching the basics and the techniques for geodata acquisition in a multidisciplinary way. The achieved main aim of the project was the creation of a internet-based e-learning platform for GIS and model based studies.

The authors will give an outline of gimolus and the subproject "Geodata acqusition and management" (GEM). The techniques like XML, PHP and Flash as well as WebGIS as characteristic of the project are presented briefly. The developed bilingual e-learning modules (English and German) make a world-wide use possible. The XML-structure provides the possibility to enhance the platform to a multilingual system.

Besides the media-didactical concept, that consists of an e-learning portion and an essential part of physical teaching in the classroom is presented and justified. Evaluation results of the lecture "Geodata Acquisition and Management" of the master course "Infrastructure Planning" at the University Stuttgart show the great acceptance of the concept by the students.

One remaining problem of the e-learning platform gimolus is the sustainability especially after completion of the project, because granting is stopped by this date. The technical maintenance of the e-learning system and even more important the questions of up-to-dateness of the teaching content within the system require a high effort of manpower and has to be financed in a way. The authors will present there strategies of sustainability and some experiences to collect fees of possible academic as well as commercial users by introducing life-long learning environments.

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1. E-LEARNING FOR GEODETIC ACADEMIC TEACHING

From the historic point of view academic teaching was physical teaching by using black-boards and, later on, computer presentations. Besides the students have to learn in self-study phases that comprise the repetition and application of the knowledge gathered in the lectures. Additionally this knowledge is deepened studying textbooks. These self-study phases were voluntary or relevant for examinations depending on the lecturer. In a next step textbooks were supplemented by electronic information sources on CD or in the internet. SCHERER (1997) and BILL and RESNIK (2000) are examples for CDs and UNIROS (2005) is an example for an internet-based encyclopedia in the field of surveying, geodesy and geoinformatics. In this article this field will be named geodesy for the sake of simplicity.
After the phase of first enthuiasm for e-learning the ideas to implement academic teaching in the form of distance learning fails for the most part. Still there are some nearly purely internet-based courses in the field of GIS e.g. at the University Salzburg (UNISALZ 2005) or at the University of Melbourne (ZERGER et al. 2002). Alternatively VIRRANTAUS (2001) proposes the concept of internet-based learning in the classroom.
In Germany the Federal Ministry of Education and Research (BMBF) launched a funding program for the development of New Media in Education in the year 2000. Most of the projects deal with internet-based teaching, the so-called e-learning. At the end most of the projects like the ones dealing with geodesy or GIS themes e.g. gimolus (MÜLLER and KAULE 2004) and geoinformation.net (PLÜMER and ASCHE 2004) came to the conclusion that a stand-alone internet-based platform will not solve all teaching problems. Besides the costs for creating e-learning modules, are very high due to the long time needed to convert simple computer presentations into really effective learning modules. Besides some lecture content requires physical teaching, especially if it is dealt with actions that have to be done in the field. A typical example is the acquistion of geodata by geodetic measurement techniques.

2. CONCEPT FOR THE INTEGRATION OF PHYSICAL AND E-LEARNING

Taking into account that geodata acquisition is a task that have to be carried through in reality, the teaching about a subject like this should reflect this fact. The way a surveying instrument has to be leveled und centered, may be learned in practical training only. On the other way the general procedure and the theoretical background may be thought in the classroom or – if we are talking about e-learning – within e-learning modules.
On the other side e-learning should not only intercede declarative knowledge, the focus should be on procedural and contextual teaching. A concept take in account both restrictions – the “consideration of reality” and the focus on procedures and contextual applications– is proposed in the following and explained on the basis of an e-learning course realized at the University Stuttgart.
The lecture is structured in a way that each theme may be taught in one or two double periods of the course. When the theme is finished in physical teaching, the student should use the

respective e-learning module, that repeats the declarative knowledge and comprises knowledge questions and applicated tasks. The students may control themselves and – in some of the modules – they have to send their more complex solutions to a tutor, who will acknowledge the work respectively give remarks for improvement. For modules that require to carry through practical training the e-learning module followed by a practical training. Figure 1 shows the procedure for a part of the course "Data Acquisition and Management" (compare chapter 2). Obviously the authors distinguish between themes that require practical field training like modules 4.1 and 4.2 and the ones that do not need this training like module 5.1.

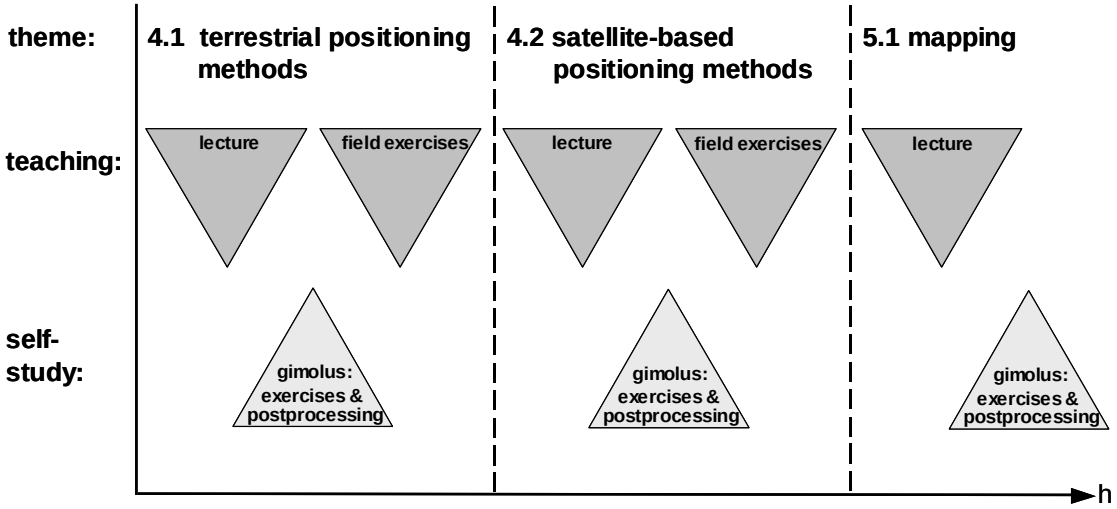

Figure 1: Combining existing teaching and self-study

Summarizing the concept contents a chain of physical teaching and self-study phases combined with practical training for the themes requiring this. The following chapters will describe the content and the technical background of the e-learning modules and will focus on the evaluation of the concept respectively the e-learning modules.

3. E-LEARNING PROJECTS AT IAGB AND CONTENT OF THE MODULES

The first step for the start of e-learning activities at the IAGB (Institut für Anwendungen der Geodäsie im Bauwesen / Institute for Applications of Geodesy to Engineering) was given by the program "Neue Medien in der Bildung" (New Media in Education) launched by the German Fereral Ministry of Education and Research. The IAGB took part at the project gimolus (MÜLLER and KAULE 2004; www.gimolus.de). Together with the Institute for Photogrammetry (IfP) at University Stuttgart the basics of GIS for the environmental disciplines involved into the project were treated. The following environmental university institutes and groups were integrated into the project:

- Institute for landscape-planning and ecology (ILPÖ) – University Stuttgart
- Institute of Hydraulic Engineering – University Stuttgart
- Landscape Ecology Working Group – University of Oldenburg
- Field Station Fabrikschleichach - University of Würzburg

Besides the didactical concept was co-developed by the media-didactic department, University of Duisburg. They were responsible for the evaluation of the project results, too. The technical support was guaranteed by the computing center of the University Stuttgart. In the following some of the gimolus related publications are given: WEIPERT and FRITSCH (2002), PAUL et al. (2003), RUDNER et al. (2003) as well as SCHWIEGER and KAUFMANN (2003).

Besides the University Stuttgart is generally very engaged in the field of e-learning. The projects launched by the rectorate are named 100-online and self-study-online. Both calls for proposals have granted more than 100 projects of almost all institutes of the university. The IAGB successfully took part at all the calls for proposals and especially the second step self-study-online yields to e-learning modules usable in the sense of modern media didactical guidelines.

The structure of the gimolus modules is oriented to the IMAP-Model (CHALKIN 1977). This model fully describes all the functionalities of a GIS, like data input (acquisition), management, analysis and presentation (visualization). Within this concept the IAGB cares about geodata acquisition for the most part. The themes that are covered by lectures are described in figure 2. It was planned to create one e-learning module for each of the themes. Due to the fact that the institute offers lectures in German as well as in English the modules are bilingual. Currently the following modules are created according to figure 2:

- Shape of the Earth (English and German)
- Coordinate Transformations (German)
- Terrestrial Positioning Methods (English and German)
- Satellite Based Positioning (English and German)
- Mapping (English and German)
- Data Processing (English and German)
- GIS-Tutorial (English and German)

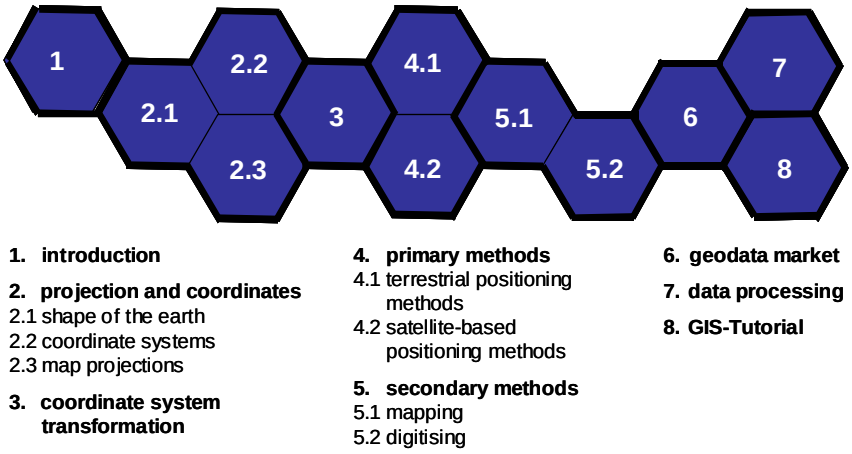

Figure 2: Overview about e-learning modules for ”Data Acquisition and Management”

The creation of E-learning modules within this concept is an ongoing task. Additionally modules are created that do not fit into this concept but deal with content that is more essential for geodesy students. Here the modules

- ActiveMap (German) and
- ActiveGeo (English) were created.

The first dealing with techniques for animated maps, the latter covering the two-dimensional geodetic computations like intersection or polar survey.
The e-learning modules created are integrated into physical teaching like described in chapter 2. Most of the modules are used for teaching of non-geodesists except ActiveMap and ActiveGeo.

Table 1: Courses and specialities

Course	**Speciality**
Data Acquisition and Management	Infrastructure Planning (MSc)
Acquisition and management of planning data (German)	Technique and economy of real estate (diploma)
Surveying for architects (German)	Architecture and urban planning (diploma)
Surveyinf for construction engineers (German)	Construction engineering (diploma)
Thematic Cartography (German)	Geodesy and Geoinformatics, Geography (both diploma)

The primary target group of the curriculum presented in figure 2 is the course ”data acquisition and management” within the master cours ”infrastructure planning” at the University Stuttgart. The students arrive with a bachelor degree for architecture, construction engineering or planning science like urban planning mostly obtained in developping countries. Building up on these different degrees they get a specialization in infrastructure planning. In general we should mention here the wide exertion of the modules. An overview about all courses and specialities is given in table 1.

4. TECHNICAL REALIZATION

Within the project gimolus an e-learning platform was programmed that is the base for all e-learning modules created by the partners of the project. The platform provides the possibilities to load up new or up-dated modules by the authors. The users may choose modules they like or only the ones that are “allowed” by the respective lecturer.
The central and connecting element of the gimolus-platform is the virtual landscape (compare figure 3). The user, with other words the student, may solve his problems in an interdisciplinary way using the same geodatabase for different problems like hydrology or environmental planning.

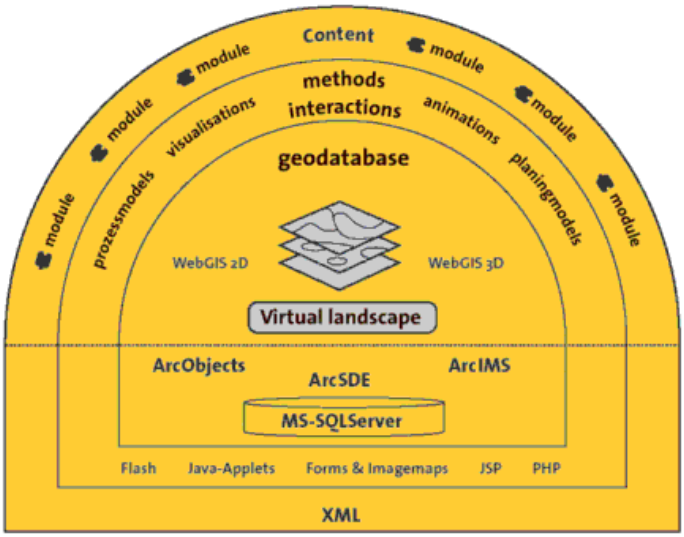

Figure 3: System architecture of gimolus-platform (MÜLLER 2004)

The virtual landscape is realized by different GIS implementations. One of it being ArcIMS as a real WebGIS implementation. The students work with the geodatabase available at the gimolus servers at Stuttgart. For the complete structure of the WebGIS infrastructue it is referred to figure 4 and to MÜLLER and VENNEMANN 2003.

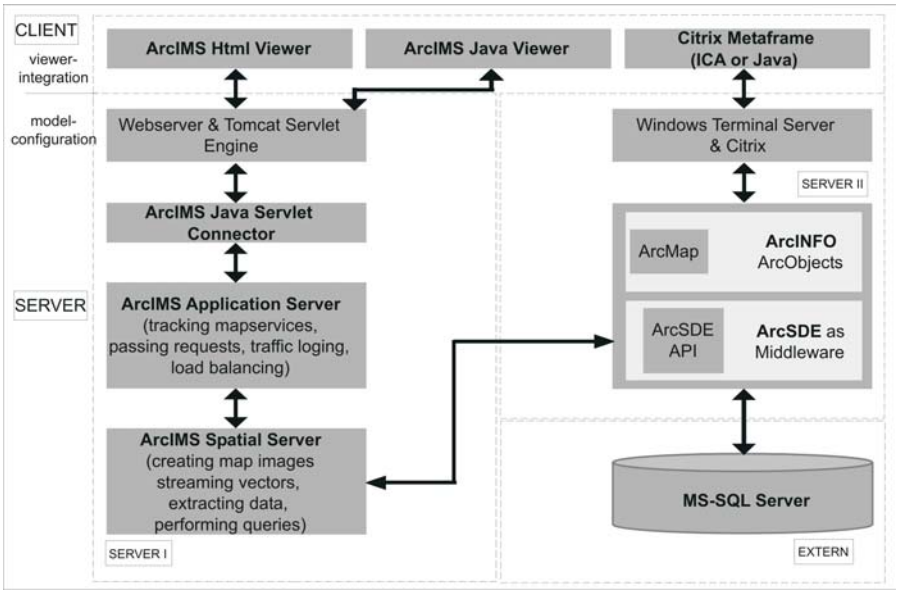

Figure 4: WebGIS- architecture of gimolus (modified according to VENNEMANN and MÜLLER 2004)

Besides the WebGIS realization animations using Macromedia Flash are used. These animations help to visualize complex processes like measurement processes. Additionally the PHP-language is used for e.g. multiple-choice tests.

The main advantage of the e-learning modules is their XML-structure. For visualization the XML-modules are converted via different gimolus-specific XSLTs to HTML-files that are visible and used via the internet (TANDJUNG and STOBBE 2004). The e-learning systeme gimolus and the modules inside the system provide the possibilities to

- change the visualization by different XSLTs,
- extend the bilingual to a multilingual system and
- the export the modules to other systems.

5. REALIZATION EXAMPLES

This chapter will present some typical realizations for data acquisitions modules. Figure 5 shows the title page of the module “mapping”. The substantial contents of the title page are visible: summary, keywords, author, prerequisite modules, requirements and a title picture as well. Additionally the general structure of the e-learning platform (work, communication, system, help) and of the modules is visible:

- chapters (introduction, manual, content, material, assistance) and
- subchapters for the chapter “introduction” (title, appetizer, objectives).

This page is the first visible to students, if they use the module or if they get an link from another module. In the latter case the student have no possibility to branch into this module, because the hierarchical navigation structure in and between the modules should be kept. The student should always know “where I am in the learning environment?”.

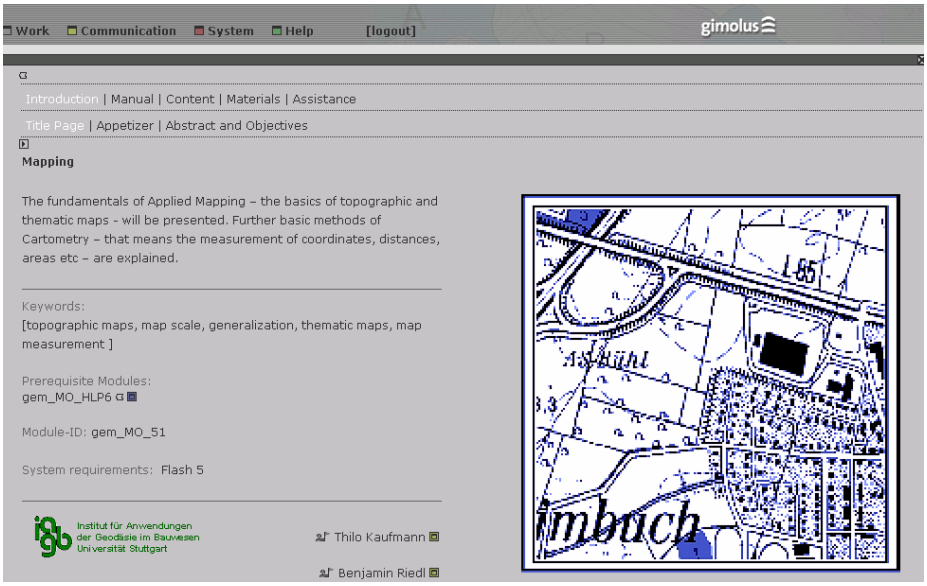

Figure 5: Titlepage of e-learning module ”mapping”

Figure 6 presents a screenshot of an animation which is part of the module ”terrestrial positioning methods”. In this module the student learn among other things the functionality of geodetic instruments. The theodolite shown provides the possibilty to measure horizontal and vertical angles. Using the animation the different parts of the theodolite may be vizualized at the touch of a button. The vizualizaion is supported by changing text paragraphs at the

bottom of the animation. The interactive behaviour of the students helps them to explore the functionallity of the instrument the way they like the most.

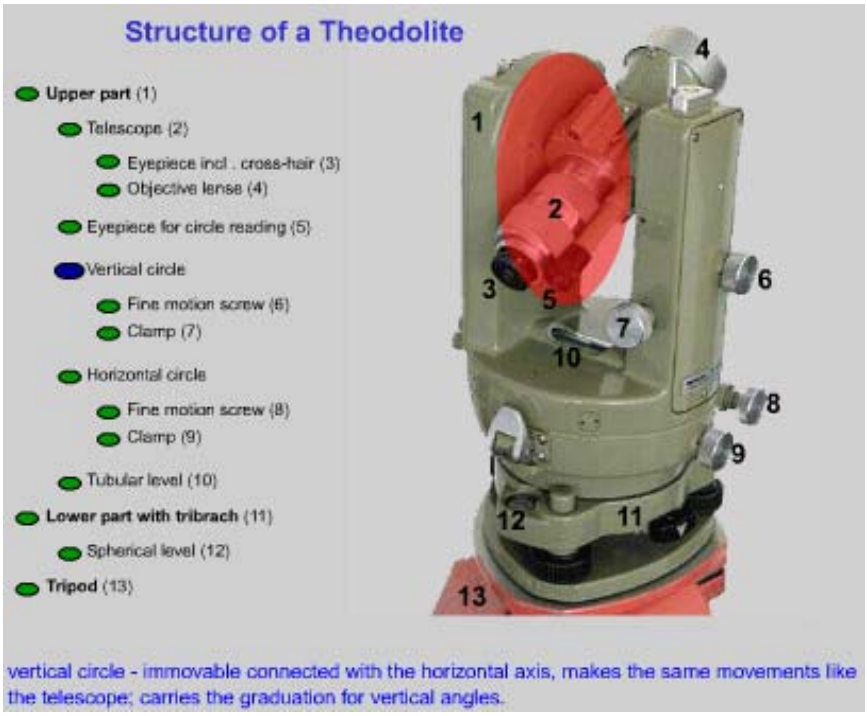

Figure 6: Example for Animation ”Structure of a Theodolit”

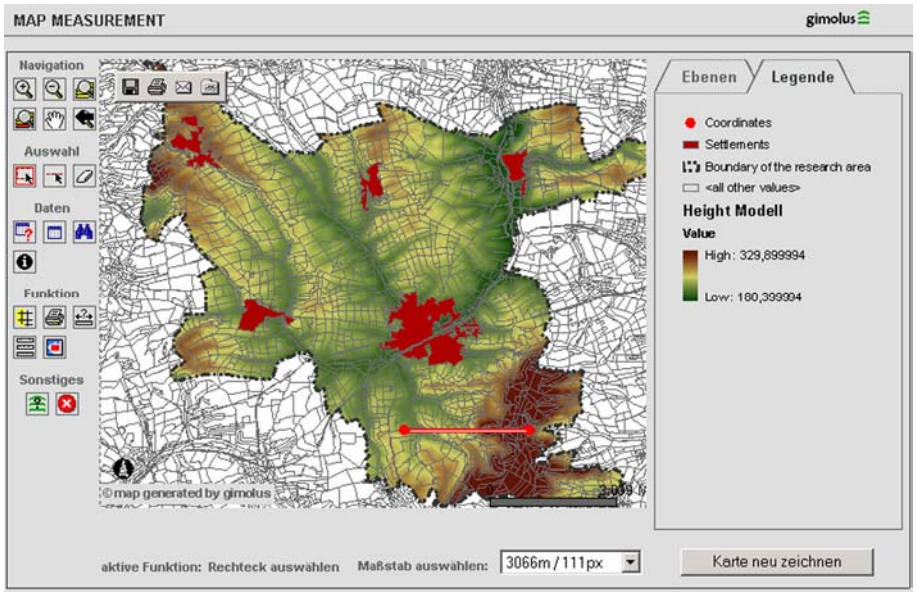

Figure 7: Example for WebGIS-Application

As representative for the WebGIS realizations a ArcIMS application is presented in figure 7. This application is part of the module ”mapping” and shows an exercise to learn basic mapping functions in WebGIS like measurement of distance, heights, coordinates. For further

realizations within the data acquisition modules is referred to SCHWIEGER and KAUFMANN 2003.

6. QUALITY ASSURANCE

6.1 Prototype evaluation

During the development of learning modules the ongoing evaluation by students and module authors is an important task. Within the gimolus project a complete evaluation procedure was developed (WIENHOLD 2004, KAUFMANN and SCHWIEGER 2004). The most important step for the future quality of the modules is the so-called prototype evaluation. For this evaluation an incomplete module in its currect state is presented to students to get information regarding improvements before the module is in its final and complete stage. Improvements may be introduced more easy.
The prototype evaluation of the e-learning modules „terrestrial positioning methods“ and “mapping” was carried through during the runtime of gimolus. The evaluation was carried through in 2002 with approximately 10 students of the master course “infrastructure planning” at the University Stuttgart. For the evaluation the instruments ISO questionnaire and workshop were used. After an introduction explaining the sense of the evaluation, the gimolus-platform, its technical background as well as the respective modules the students have the time to explore the modules and to answer the questions in the questionnaire. The evaluation of the questionnaire was the base for the content of the workshop. The strongest possibilities to improve the modules and the platform are found in the ISO-questionnaire items “suitability for learning” and “suitability for individualization” (compare table 2). The workshop helps to identify the problem fields more in detail. Table 2 shows the results of the workshop.

Table 2: Results of prototype evaluation

ISONorm9242/10-questionaire	**Prototype-Workshop**
suitability for learning	• glossary • readability • help-button • unique animations
suitability for individualization	• bookmarks • download • personal highlighter

Based on the results the “suitability for learning” was improved for the two modules and for the modules developed in the following as far as the critics could be transferred. The improvements regarding “suitability for individualization” could not be realized, because they concern the gimolus-platform itself and the authors were not allowed to intervene directly into the programming process. The integration of the tools for individualization was not processed due to the lack of time within the project runtime although everybody agrees that they would improve the over-all acceptance of the e-learning system.

6.2 Evaluation of e-learning modules

After module finalization taking into account the ideas of the prototype evaluation the final modules were deployed in teaching according to the concept presented in chapter 2. The modules were presented to different specialities (compare chapter 3). The e-learning platform as well as the individual modules were evaluated by the students. At the evaluation the following test groups take part:

- geodesy and geoinformatics, geography. (in this article these students will be named geodesists for the sake of simplicity).
- technique and economy of real estate and
- infrastructure planning.

The sample size is between 6 and 18 students per module and speciality, in total 92 students take part at the evaluation. A special questionnaire was developed for these evaluations, a combination between the ISO questionnaire and a standard questionnaire developed at the University Stuttgart. It was handed out to the students and they were made a plea for completing the form during their use of the modules. The questionnaires were collected afterwards. The figures 8, 9, 10 and 11 show values from 1 to seven on the vertical axe. One stands for “I completely disagree” and seven for “I completely agree”. The values between indicates steps between the extreme values, thereby four indicates the medium value. In figure 8 the experiences and expectations of different student groups are presented.

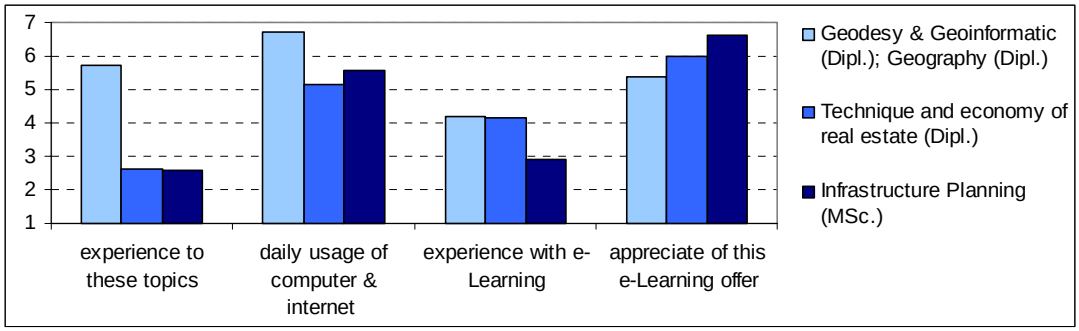

Figure 8: Experiences of target groups

As expected geodesy students have more experiences to the topics of the e-learning modules. That is not surprising, because their study focusses on these topics whereby the non-geodesy students (infrastructure planning, technique and economy of real estate) have almost no experience in this field. The geodesists as engineers also have the best knowledge regarding computers and internet. If we switch to e-learning the ”infrastructure planning” students have the lowest experience but show the highest enthuasiasm.

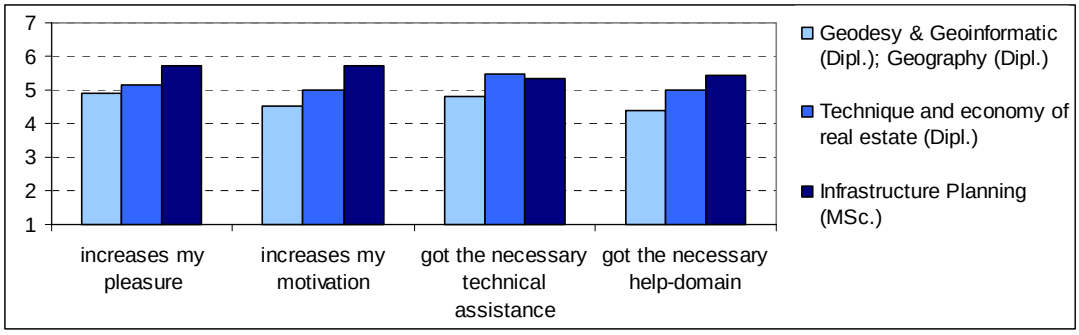

Figure 9: Evaluation of e-learning system gimolus

Figure 9 presents the evaluation of the gimolus platform. The three test groups have a postive judgement of the system, but all of them sea still possibilities to improve it. This is indicated by the marks between 4.5 and 6. The ”infrastructure planning” students are the ones that like the system the most, ecpecially regarding pleasure and motivation. Although it have to be noticed that these are the ones that have to use the e-learning modules as relevant for examinations. Their internet-based exercises have to be ackowledged by a tutor, in general the responsible scientific associate. After ackowledgement of all internet-based exercises they were allowed to take part at an oral examination.

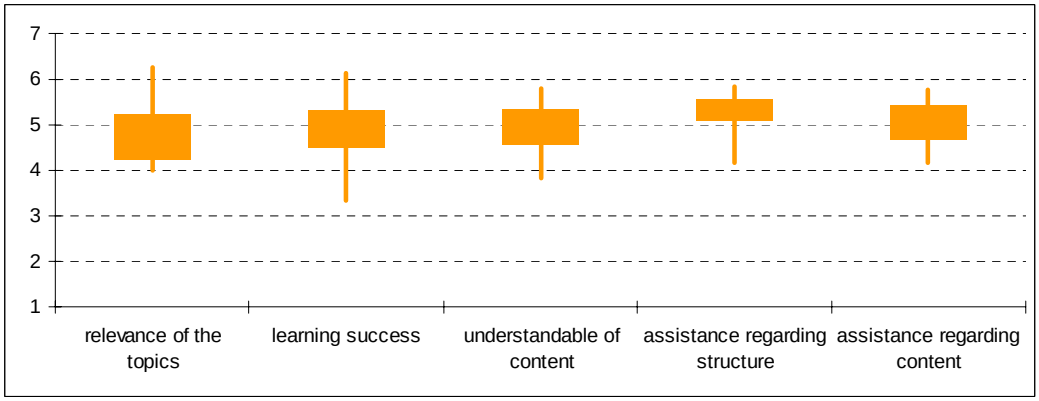

Figure 10: Evaluation of modules

In figure 10 the authors migrate to the evaluation of the single modules. Some of the modules were tested by all three test groups, some only by one or two groups. The figure presents the results for module-related questions. For each module and test group has to be understand as one sample and delivers a result. If it is summed up we have ten samples (compare figure 11). The box plot shows the 25 % and the 75 % quantil in the middle bold area for theses results and the outer limits stand for the maximum and minimum value for all modules. We may conclude that the average values are fairly good for all modules (around 5).

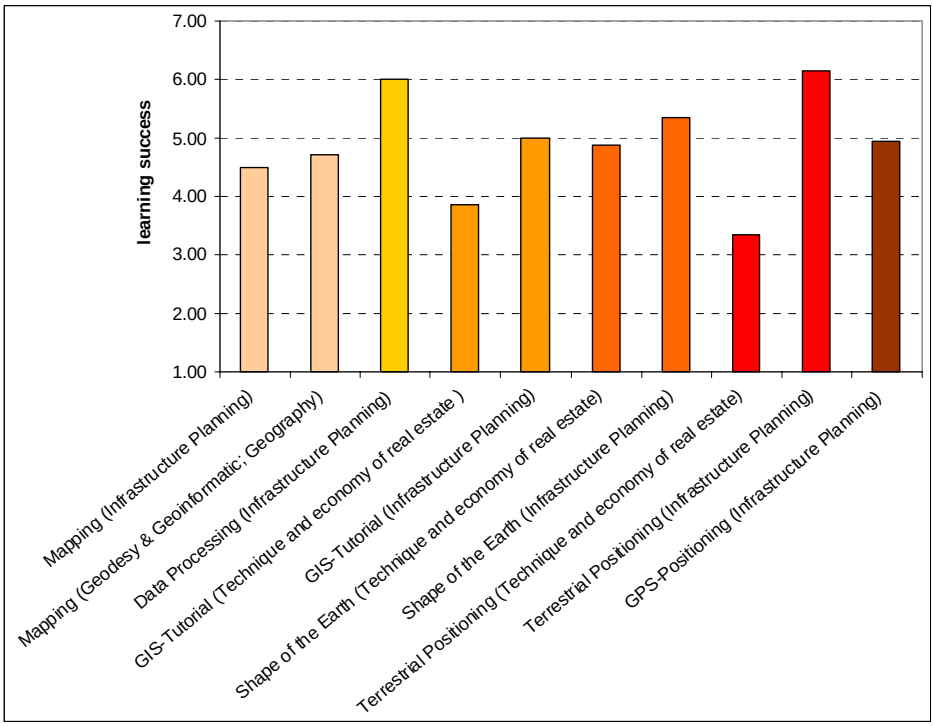

Figure 11: Evaluation of item ”learning success”

Sometimes the variation is quite large, in the case of the ”learning success” we have values between 6.1 and 3.3. These differences are due to the different settings of the test groups meaning the interests and knowledge of the students, e.g. students of ”technique and economy of real estimate managers” have less previous knowledge compared to infrastructure planning students. This fact is underlined by figure 11, that shows the different results of the test groups for the different modules exemplary for the rather important item ”learning success”. Based on these evaluation results some parts of modules were supplemented as well as the integration of modules in some courses was arranged.

7. SUSTAINABILITY

For gimolus as for all other projects granted by the BMBF the financial aid was restricted to the runtime of the projects. On the other hand – as we present in this article – the e-learning modules are integrated into the curriculum and are accepted by the students. Due to these facts the assurance of the further working of the e-learning system as well as the update of the content is a serious problem. Currently we have three concepts for the sustainable maintenance of the e-learning system:

- new project money,
- collection of fees from the academic institutions using the modules and
- use the system for life-long learning activities accompanied by fees too.

The first one is again a temporal financing, so to our point of view it is not preferable at all. The second and third activities have been pushed to start and show first positive results. The maintenance of the system is realized by the three institutes (IAGB, IfP and ILPÖ). The three

institutes collect fees from the other institutes, that use the modules for teaching, to finance the personal effort and the software and hardware update.
The vision in the sense of sustainability is the dual-use of the system as an academic teaching system as well as a life-long learning environment. A first start have been done here too. The course successfully takes part at the UNIGIS master course as an elective named "Data Acquisition and Management" for the first time. The standard implementation in curriculum within this master course is the aim pushed forward by IAGB. Additionally the authors are in discussion with authorities and schools that may like to use the system for teaching purposes. The idea is to create one e-learning system that may be used for academic teaching, life-long learning and extended vocational training.

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BIOGRAPHICAL NOTES

Volker Schwieger

1983 – 1989	Study of Geodesy in Hannover
1989	Dipl.-Ing. in Geodesy (Hannover)
1991 – 2000	Scientific Associate at Geodetic Institute, University Hannover
1998	Dr.-Ing. in Geodesy (Hannover)
2000 – 2001	Scientific Associate at GeoForschungsZentrum Potsdam
2002 – 2003	Scientific Associate at Institute for Applications of Geodesy to Engineering, University Stuttgart
2003 -	Head of Department "Positioning and Measurement Techniques" at Institute for Applications of Geodesy to Engineering, University Stuttgart
2004	Habilitation for "Estimation Methods in Engineering Geodesy" (Stuttgart)

Thilo Kaufmann

1995 – 2001	Study of Geography in Tübingen
2001	Dipl.-Geogr. (Tübingen)
since 2001	Scientific Associate at Institute for Applications of Geodesy to Engineering, University Stuttgart

CONTACTS

Dr.-Ing.habil. Volker Schwieger / Dipl.-Geogr. Thilo Kaufmann
University Stuttgart, Institute for Application of Geodesy to Engineering
Geschwister-Scholl-Str. 24 D
D-70174 Stuttgart
Germany
Phone: +49/711-121-4064 / -4060
Fax: +49/711-121-4044
Email: volker.schwieger@iagb.uni-stuttgart.de / thilo.kaufmann@iagb.uni-stuttgart.de
Web site: http://www.uni-stuttgart.de/iagb/
Gimolus web site: http://www.gimolus.de/